ARMY ORDNANCE

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For Victory through Armament Research, Production, and Supply

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THE ARMY ORDNANCE ASSOCIATION

The Aims, Purposes, and National Officers of the Society

THE Army Ordnance Association, a national society of over 15,000 American citizens, was founded in 1919, "pledged to industrial preparedness for war as our nation's strongest guaranty of peace." The society was incorporated under the laws of the District of Columbia in 1928. Its entire energies are now dedicated to victory for the armed forces of the United States. For the duration of the war it is "pledged to victory—complete, absolute, final."

The Association has endeavored during the past twenty-three years to keep alive an interest in and knowledge of the design, production, and maintenance of military armament. This it has done through periods of public lassitude and times of great national emergency. Until 1940 there was no peace-time armament industry in the United States for the production of ordnance. Now all American industry is being geared rapidly for victorious war production.

The principal objective of the society is an active membership of American citizens to assist in the design, development, procurement, production, maintenance, and supply functions of the Ordnance Department of the United States Army. When peace returns, this body of informed citizens will again continue to be a bulwark of knowledge, experience, and ability upon whom the Armed Forces of the United States can rely for technical and scientific assistance and for industrial preparedness.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its elected officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is four dollars a year. (Application facing p. 536.) There are twenty-one local chapters of the Association throughout the United States.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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This is one of a series of posters designed and published by the Ordnance Department, U. S. Army, as a stimulus to war production in armament plants throughout the country.

ARMY ORDNANCE

Volume XXIV MAY-JUNE, 1943 No. 138

Firepower for Victory

New and More Deadly Weapons Are Now in Production

Maj. Gen. Levin H. Campbell, Jr.

THERE is no section of industrial America which has made a more outstanding contribution to the success of American fighting forces than has the industry which comprises the Cincinnati Ordnance District. Under the leadership of its officials, the Army Ordnance Association in this area also has made, over the years, an outstanding contribution to the efforts of the Ordnance Department of the United States Army for adequate armament.

My message is one of confidence in our American ordnance—confidence in the engineers who design it, confidence in the men and women of industry who make it, confidence in the soldiers who supply and service it on our far-flung battle fronts, confidence in the finest soldiers on God's earth who win battles with it. Our armament is winning battles. I will mention later some surprises we have for our enemies, but first let me give you a brief picture of how we of the Industry-Ordnance team have made the grade. It's been a long, hard pull, and the results didn't happen by chance.

Little did we dream, some twenty-four years ago when the Army Ordnance Association was formed, of the great part it was destined to play in the affairs of this nation. Little did we dream that, largely due to the Association's indefatigable work and high efforts, the great Ordnance Department of the Army would be enabled to begin instant production and, with your unfailing help, to perform its allotted task in the defense of our nation. Surely there is no other national society which has contributed more to its country's welfare than has the Army Ordnance Association.

WAR imposes great burdens upon us all, but none is greater than the burden borne by the Ordnance Department of the Army. Its task is one of the greatest in our entire national offensive effort. Upon Army Ordnance rests the duty of developing, designing, producing, supplying, and maintaining the death-dealing weapons with which our armies and those of our stalwart allies are equipped. Upon the quality of these weapons depends the success of our armies. Upon these weapons depends the length of time required for the American banners to fly in victorious array in Tokyo and in Berlin. That is a great responsibility. Let me assure you, on behalf of my fellow members of the Ordnance Department, both officers and civilians, that the Department will not be found wanting in its trust. It has not failed during the 131 years of its glorious history. It will not fail now!

General Campbell is Chief of Ordnance of the U. S. Army. This is an address delivered at the annual dinner meeting of the Cincinnati Post of the Army Ordnance Association on March 27, 1943, at the Netherland Plaza Hotel, Cincinnati, Ohio. The address was broadcast over the Red Network of the National Broadcasting Corporation.

Let me very briefly outline the organization of the Army, so that the place of the Ordnance Department is clearly understood. First, we have as its Commander in Chief the President of the United States. Reporting directly to him is the Secretary of War. Under the Secretary of War, for military operations, is the Chief of Staff, and for industrial operations, the Under Secretary of War.

Then we have reporting directly to the Chief of Staff, for military activities, the Army Air Forces, the Army Ground Forces, and the Army Service Forces (formerly known as the Services of Supply). For the industrial aspects of their huge task, the Army Service Forces report directly to the Under Secretary of War, Robert P. Patterson. The Ordnance Department is the major service of this producing and servicing organization. It reports directly to Lieut. Gen. Brehon B. Somervell.

THE Ordnance Department is divided into four principal divisions, which I will describe. First, there is the Research and Development Division under Maj. Gen. G. M. Barnes who is, without question, the leading Ordnance engineer of the world. I say this without qualification because I know the principal ordnance engineers of the armies of the world, including those of our present enemies. It is largely due to the genius of this man—working in close coöperation with the great engineering research organizations of the country and fortified by the unstinted aid of American industry—it is due to his genius that I am able to say to you that we of the United States Army are, weapon for weapon, ahead of our enemies. Our Research and Development Division engineers are responsible for developing and designing the great range of weapons and equipment required by the American soldier on the field of battle.

There is no phase of Ordnance activity of greater importance than research and development. Have no fear about this, and mark it well: With the continued help of the great scientific resources and the great engineering organizations of this country we in the Ordnance Department are keeping our fighting men far ahead of our enemies. There is nothing that our enemies have disclosed which gives us any reason to doubt the superiority of American creative ability. In the firepower of our weapons we are out in front. We intend to stay there!

The next great division of the Ordnance Department has to do with armament production. It is under the direct command of a stalwart manufacturing executive, Maj. Gen. Thomas J. Hayes, most of whose long service in the Army has been connected with the manufacture and production of weapons. General Hayes operates through the thirteen

Ordnance procurement districts which cover the entire United States. The Ordnance districts are no new idea; they have been in operation for the past twenty years. One of them has its headquarters here in Cincinnati. It is under the direction of one of our most capable Ordnance officers, Col. Fred A. McMahon. The Ordnance Department in its activities is decentralized so that a most direct and intimate contact with industry is possible throughout this broad land.

As further evidence of Ordnance decentralization, our ammunition and explosives plants are administered from an office in St. Louis. It is not necessary for the operators of any one of those plants to travel the long miles to Washington for advice and assistance, because St. Louis is in the geographical center of the area in which those ammunition plants are located. The answers are to be found there—not in Washington.

The great safety and security organization which protects our plants against all types of accidents and against enemy sabotage is located in Chicago—not in Washington. The Ordnance Tank-Automotive Center which directs the development, design, procurement, supply, and maintenance of all automotive equipment for the entire Army is located in Detroit—not in Washington. And so on. Ordnance works with industry—in the laboratory, at the workbench, on the production line. I have never known of a single shell that was produced at an office desk. You don't produce weapons there. You make them in the foundry and at the machine. That's where ours are being made—not in Washington.

The Ordnance Department has carried its administrative functions out into the industrial centers of this country. There can be no doubt about the great success of the Department, and it is in no small measure due to this policy of decentralization. The Ordnance Department is not the master of industry—industry is the partner of Ordnance. Our six arsenals manufacture less than five per cent of the total ordnance requirements of our fighting forces. Those arsenals are the finest investment this country has ever made. It was these arsenals which, in the early days of this war, disseminated the "know-how" of ordnance manufacture throughout American industry.

I say that the production of ordnance is an art unto itself. Proficiency in the ordnance art does not come overnight. It must be sustained, especially in time of peace. On countless occasions, you of industry have graciously acknowledged your debt to the Army Ordnance arsenals. I take this occasion to express again to industry—and by industry I mean every man and woman in every company engaged in ordnance design and production—my sincere appreciation and my enthusiastic praise for the great contributions which it has made and is making toward bringing about the certain success of our armies in the field.

THE third great division of the Ordnance Department is the Field Service. It is under the command of an outstanding soldier, Brig. Gen. J. S. Hatcher. Field Service is charged with the supply and maintenance of all weapons to our troops in the field. The task is beyond the comprehension of the finite mind! We have more than seventy-five American expeditionary forces operating over the face of the globe today, and it is the duty of Field Service to supply those forces with our weapons and to maintain the weapons and automotive equipment in operating condition. A gun which will not shoot, a tank which will not run, and a bomb which will not explode may well lose a battle and a war. The task of Field Service is to see that such things do not happen.

When I tell you that more than 20,000 officers and many thousands of enlisted men are engaged in Field Service activities you will be able to get some slight idea of the vastness of the magnitude of this supply and maintenance problem. No army in modern war can advance or be assured of victory unless it is supported by a strong and self-reliant ordnance field service.

The next great division of the Ordnance Department is that of Military Training, which is under the control of Brig. Gen. H. R. Kutz, a Field Service soldier of long experience. Who better could be charged with the training of Ordnance troops in the field than one who has spent most of his service in that field? I often say to my friends: "If you wish to see what American youth is today and if you wish to have thrills of patriotism course through your being, come with me to one of our Ordnance schools. Come with me later to the Army in the field and watch these wonderful young men of Ordnance performing their duties of supply and maintenance, only through which can our armies be assured of success." This vast Ordnance school system is under the direct eyes of the leading educators of our country who are on the advisory staff for the school system.

There you have the basic organization of the Ordnance Department—you see how we are set up to best discharge our duties under these four competent men heading the principal divisions of the Department. Of one thing I am sure: No paper organization spells success; the men who are directing the organization make it! I have introduced you—at long range, to be sure—to the men who head the Ordnance organization for our Army. American industry—in office and factory—will testify that these men, and their many able assistants, know their jobs and are doing them well.

FROM an industrial standpoint, the Ordnance Department is guided by the one principle that it must be a unit with industry. We accept and we welcome industry in sharing our task, and we gratefully acknowledge the part that industry is playing in the admitted success of the Department. With such backing we cannot fail! To the scientists and engineers of this country we give grateful acknowledgment for the part they are playing in constantly improving the quality of ordnance equipment.

All this being so, how is it that public confidence in the performance of our weapons is challenged so frequently? There seems to be abroad in the land a spirit which does not like to admit that anything its own Army, including its own Ordnance Department, is doing is the equal of that being done by the enemy. I often believe that this sort of thing springs from Berlin and from Tokyo, and that it is stupidly picked up by shallow thinkers within our country. In minds which do not think or follow through, the propaganda of the enemy is accepted and even magnified.

The other day, we will recall, the Germans showed a monster tank weighing sixty-two tons on the battlefields of Tunisia. The tank was armed with an 88-mm. gun of a design ten years old. Immediately, certain elements of this country cried out that your Ordnance Department had been caught off guard; that the Germans had put another one over. It was said that we had lost a battle by reason of the lack of foresight of the Ordnance Department.

Actually, what are the facts? Your Ordnance Department produced a 60-ton tank sixteen months ago, but it was found

by the Armored Forces to be too heavy, too large a target, and—most important—to lack maneuverability. It was therefore rejected and was not put in quantity production. Our Armored Forces, on the other hand, said we should have a larger gun and, above all, a gun of greater maneuverability. So the M7 self-propelled mount, carrying the 105-mm. howitzer, put in its appearance before El Alamein. Thereupon Marshal Rommel began his precipitous retreat through Tunisia. How very right were our Armored Forces in their selection of this gun!

All this was going on behind the scenes, and during all this time your Chief of Ordnance knew of the German monster tank. Because of the great size of target presented, those German heavy tanks are the answer to the artilleryman's prayer! Do you know how many of the forty-five tanks the enemy once had are still in existence? Well, you needn't worry!

MAJ. ZEB HASTINGS, aide to General Somervell, Commanding General of the Army Service Forces, is the officer who named the new weapon the "bazooka." This was a spontaneous reaction on his part upon seeing the secret weapon for the first time last summer. Major Hastings will be gratefully remembered for this contribution to the Ordnance vocabulary!

The "bazooka" is the result of long experiment by the Ordnance Department and is now standard equipment for certain classes of troops. It is light enough to be carried easily by one soldier but is designed to be operated by a team of two men. Such further details of the new weapon as have been made public are given on page 550 of this issue.—EDITOR.

HERE'S one the enemy hasn't told you about. The secret weapon which I am about to describe—it has been dubbed the "bazooka"—is a new weapon which, carried in the hands of a soldier, can destroy any enemy tank on the battlefield today. This weapon has been successfully used by our forces in Africa to destroy fortifications and tanks. It is so simple and yet so powerful that any foot soldier using it can stand his ground with the certain knowledge that he is the master of any tank which may attack him.

During recent operations in Africa, a small but strong fort gave considerable trouble to the Americans. One lone American soldier detached himself from the landing party, waded ashore, and with one shot from his weapon effected surrender of the fort. That will be known as the saga of one American soldier and his "bazooka."

On another occasion, an American soldier armed with this weapon was suddenly confronted by six tanks. Unobserved, he fired hastily from cover. The projectile missed the tanks, but felled a large tree. The tank commander, an experienced officer, surrendered! The Americans were astonished. The tank commander explained:

"When you start firing 155-mm. guns at tanks, it's time to surrender!"

These are but two of many reports about the phenomenal firepower of this weapon. It has long been in mass production and is being supplied in quantity to both American and allied forces.

Here's another one you haven't heard about. We have a new high explosive which is more than one-third greater in its destructive effect than is TNT. The enemy propaganda bureau hasn't told you of this!

May I also tell you that our Ordnance weapons are tested and proved at a proving ground in the far north where temperatures go as low as 50 degrees below zero, and at another proving ground where temperatures reach 130 degrees Fahrenheit in the shade. In addition, our machine guns and cannon are tested in airplanes flying miles above the earth in the rarified atmosphere found at those altitudes.

We in Ordnance advocate big guns. We have them designed and types perfected. They are ready for battle any time the battle commander gives the word!

We have at our laboratories and at our proving grounds the outstanding scientists of this country whose names are known to you all. The great American automobile industry that has led the world in automotive engineering is working practically one hundred per cent for the Ordnance Department in its development of tanks, combat cars, self-propelled mounts, tank destroyers, and all other automotive equipment supplied to the forces of the U. S. Army.

WE Ordnance engineers stand, above all, for firepower. We know that it is not the size of a tank or the width of a gun carriage that destroys an enemy. We know rather that the amount of steel and high explosive we can deliver at the enemy target is what will win battles and eventually will win this war. So we in Ordnance urge that we keep ever before our minds the one word "firepower." We engineers express it in another way by a simple little mathematical expression—$\frac{1}{2}MV^2$—where M is the mass of the projectile and V is the velocity. You can readily see from this that if we have projectiles or bombs of the greatest possible mass and of the highest reasonable velocity we are bound to deliver at the target the greatest destructive effect. Let no one doubt that your Ordnance Department stands for *firepower* which, in turn, stands for destruction of our enemies and certain victory.

The American public should know and keep ever in mind that war by its very nature is fluid, because in war man is striving to preserve that most precious thing of all—life. We, as well as our enemies who are engaged in the design of weapons, are constantly striving to put into the hands of our troops weapons of the greatest destructive quality. The American public would want your Ordnance to do its best. Surely you would want your Ordnance Department to change, to modify, and to improve the weapons of war whenever our American engineering genius brings forth better weapons. You will not permit us to do less. We would not be true to our trust should we do less.

When our armies in the field tell us in Ordnance that they must have a different tank, a different gun, a different bomb, a different shell, a different projectile, we—the servants of the fighting men—immediately translate their wishes into action. So if contracts are terminated, if models are changed, if orders are increased or decreased for any particular items, and if unfortunate dislocations of employment are caused, Americans will know that it is but the expression of their boys on the field of battle as the tide of conflict changes. You Americans will honor such expressions and you will let no selfish interest sully this great patriotic united effort of all our citizens.

Industry in the Postwar World

Today's Research Will Open New Avenues of Production Tomorrow

Arthur W. S. Herrington

WHAT kind of a nation are we destined to be when this war is ended? What will be the position of industry in that nation? What has the engineer to offer as products for that industry of tomorrow? What is to be our relationship to the other nations of the world? Can we hope that, out of the misery and suffering of today, we can construct a new world which will truly be a better place for all people?

These questions come tumbling upon us at a rate which is only exceeded by the rapidity of the changes into which this war has plunged us.

We, the people of the United States, are the ones who will determine the nature of our postwar country. It seems improbable that we would permit a mere handful of large and power-hungry, competition-fearing monopolies to plunge us into the fascism our boys are now giving their lives to eliminate from this earth. It is equally unlikely that our solution will be found in tearing up the system of free enterprise which has done much to bring us to our present position and substitute for it some untried socialistic and communal form which is the brain child of a theorist who has had no contact with industry and its components. Equally unacceptable to us will be any negative scheme which presupposes the necessity of a reduction of our accepted high standard of living. In this free land of ours the only barriers to the development of opportunities are the failings of men themselves.

Our American people are patient and long-suffering, but once they perceive a goal of opportunity, they cast aside all extraneous issues to step forward to that solution which will bring the greatest good to the most people. We will not give up the liberty we have so dearly won. We must recognize that we are in the midst of one of the ever-recurring revolutions which tend to refine and improve our democratic form of government.

Freedom is a priceless thing, and the right to it requires an endless vigil. The thought is best expressed by this quotation from "The Drums of Morning":

> The fight for freedom is an endless battle. Its victories are never final; its defeats are never permanent. Each generation must defend its heritage, for each seeming conquest gives rise to new forces that will substitute fresh means of oppression for the old. There can be no peace in a world of life and growth—every battle the fathers thought finished will have to be fought anew by their children if they wish to extend their freedom.

Out of the accelerated technical developments which always follow in the path of war has come a glorious accomplishment by American creative genius. A year ago industry was under fire—the fire of unjust and ill-informed critics accusing industry of having failed to convert its plants to the production of our country's urgent war needs. Little heed was paid to the fact that we did not possess a nation-wide munitions-producing industry. It takes time to design and tool for the manufacture of products with which we had had no previous production experience.

The simple fact remains that within the short period of twelve months our production of war material has reached flood proportions, and our Commander in Chief, the President of the United States, has called it a "production miracle." This miracle is merely a graphic illustration of the potentialities of our system of free enterprise. In less than two years, *in our American way,* we have attained production records which could not be reached by the stealthy dictators in all their sneaking, hidden years of preparation!

RESEARCH is pushing the frontiers of industrial opportunity outward at a rate which we could not possibly conceive two years ago. In our urgent search for means of locating enemy air- and water-borne military units, we have turned to electronics with amazing results. These developments will bring greater changes to our every-day postwar life than did the coming of the radio. All sorts of labor-saving controls will come from the ultimate commercial development of these new discoveries. The wireless transmission of electrical energy is not a too-far-distant possibility. Electrons originally harnessed only in radio tubes are now our able laboratory assistants in a much broader field. The photo-electric cell is becoming the "seeing eye" of industry. The electron microscope is daily increasing our knowledge of the physical structure of matter.

The complicated chemistry of the hydrocarbon is unfolding under our improved knowledge in the use of catalysts. The octane ratings of our aviation fuels are soaring upward. Noninflammable fuels of high energy content which will not burn in open air have already been created. At present, our fuel developments have outstripped the ability of our motor designers to use these new sources of energy. In the laboratories of my own company, we have been studying the problem of test engines to properly evaluate the energy content of these new chemical creations. One of these special test engines is already running with an I.M.E.P. of 500 pounds, and another engine, which has been specially designed to operate upon small quantities of these fantastically expensive samples, will develop an I.M.E.P. of 850.

To those of us who have considered the airplane a possible transporting medium for the world's goods in commerce, these discoveries open a new field of possibilities. The reduction of the ton-mile cost of cargo transportation is determined by the speed and the laden to unladen weight ratio. There seems little hope of any radical change in the specific weight of the materials out of which an airplane can be built. Our efficient use of the materials available has already attained a high standard. Obviously, the one factor still open to attack is the volume of airplane fuel required to be carried

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Mr. Herrington is chairman of the board of the Marmon-Herrington Company and a director of Aviation Corporation. He is also president of the Society of Automotive Engineers and a national director of the Army Ordnance Association. He served in World War I as a captain in the G-4 section of the First Army and subsequently held a commission as major in the Quartermaster Corps Reserve. He was appointed by the President to serve as technical adviser to Col. Louis Johnson on the American Economic Mission to India. He also served for several years as consulting engineeer to the Shah of Persia and was responsible for increasing the efficiency of the mechanized units of the Iranian Army.

which is determined by the energy content of this fuel. Airplanes capable of carrying a capacity load and spanning the Pacific nonstop bring no comfort to our enemies and leave us with a few postwar problems of our own.

OUR knowledge of aërodynamics is also undergoing a major revision and revolution. As we attain aircraft speeds in excess of 500 miles an hour, air starts to react in ways to which we are not accustomed; air screws, commonly called propellers, do not function as we have expected them to. As our speed through the air reaches the speed of sound, we find some new rules must be devised by our research staffs. When propellers are no longer efficient we must turn to orifice or jet propulsion. Such sources of propelling power, exceedingly efficient at high altitudes, have presented some low-altitude problems we are just on the verge of solving.

The airplane which can be flown by the individual of average physical qualifications is even now available. The impetus of postwar industrial development will so reduce its cost as to broaden its useful field to unpredictable proportions.

The new control and development of catalysts has opened other fields to our chemists. The whole catalytic field is emerging from the days of the long and costly use of the Edison method. By new microscopes we can mathematically determine the kind of catalyst needed and predict the resultant reaction.

In biochemistry we find the development of penicillin, which is less toxic than sulfanilamide and infinitely stronger. Hormones and vitamins are all being regimented to meet the many problems of overcoming malnutrition and fighting disease in the new and smaller world as developments in transportation make neighbors of the nations.

Synthetics of all kinds have been developed, and we may never again turn to our old sources of supply for certain basic raw materials. New organic chemical combinations hitherto unheard of are only awaiting an opportunity of commercial development.

In the field of metallurgy, the necessities of our war economy will provide us with many new materials formerly too expensive for industrial use. The physical properties of our basic steel have been improved to the point where its possible use is materially expanded. Beryllium and boron are coming into commercial use as alloying agents. Two metals possessing most unusual properties have come into common use. These are beryllium nickel and beryllium copper. Beryllium copper was the means of solving one of our aviation headaches. The high altitudes which are today a definite military requirement present real design problems in aircraft accessories. We were recently required to develop an air compressor capable of compressing 60 cubic inches of air at 1,000 pounds per square inch at an altitude of 40,000 feet in 20 minutes at minus 70 degrees Fahrenheit. This performance was made possible by a beryllium copper valve of unique and unusual design.

New hard metals for cutting tools are speeding up our manufacturing processes. These new cutting materials have been a major factor in providing us with the speed-up processes necessary to meet the requirements of our urgent military supply problems. It has been necessary for our machine-tool designers to completely revolutionize their designs to take full advantage of the effective cutting speeds and feeds possible with tungsten carbide.

The light metals, aluminum and magnesium, have experienced phenomenal development. New processes for the extraction of aluminum from lower-grade bauxite ores have materially increased our sources of supply. New and larger producing capacity for strips and shapes, with corresponding reduction in cost, will broaden the use of these materials in our postwar world. We may find an increasing use of aluminum in railroad cars and automobiles. Magnesium, which is about sixty per cent of the weight of aluminum, has been through similar production development. When this war is over we will be producing twice as much magnesium as we were producing aluminum in 1939.

Out of these new developments in high-tensile steel and aluminum may easily come some radical changes in our postwar automobile industry. As one who is active in both industries, it may be possible for me to hazard an answer to the recently expressed fears of the airplane manufacturers that the automobile men may invade the aviation field when the war has ended. It seems to me that there is far greater chance of the wide-awake aircraft designers applying their newly acquired skills to the problems of automobile design and production, because our postwar motorcar will definitely be lighter and more economical to operate.

Glass in the past two years has developed more possibilities than in all the prior years of its existence. Not only have we advanced in the production of optical glass, but this material now will be found in other fields where it was never used before. Combined with metals and plastics, a new series of products becomes available.

The farmer in solving his postwar economic problems will find his sources of cash income greatly broadened. Instead of being confined to the food markets, the chemist will have unleashed for him a host of customers in industry. New and more powerful fertilizers will reduce the man-hours of effort and increase the production value of his work-hour.

Surely, from all this accelerated research our industry will not be short of product possibilities. With the increased plant and producing facilities we have created and with the shortage of all types and characters of goods existing, we will have a domestic economic pattern which should assure adequate employment after this war.

ALTHOUGH our production now is basically for the purpose of destruction, we are all confident that it will provide us with the means of ultimate victory. When this day comes, the measure of our greatness and worthiness will be our ability to turn these forces to an effective peaceful purpose. In this reconstruction of our own peacetime economy, certain problems will arise which will have an influence on the well-being of those who have been our allies in this war. All our domestic solutions must be carefully weighed in relation to their international impacts. There is a definite challenge to our ingenuity in avoiding postwar unemployment. Up to this time we have only succeeded in abolishing unemployment during the last war and during this one.

We will be living in a new world. It will be just as impossible to turn back on the results of this accelerated research as it will be to turn back the inevitable passage of time. In this new world we will be forced to take our proper position in the family of nations. Our refusal to accept the duty and responsibility of our international obligations may easily bring about the end of our civlization. We must align our thinking with the new economic and geopolitical issues we will have to face.

The technical developments of aviation will be so great in the next five years that never again in our history will England or any other nation be able to act as a buffer for us and hold off an aggressor until we get our production machinery rolling. We will live in constant danger of having our existing producing facilities destroyed before we are aware that we have been attacked. In the future, our national security demands that we must ever be prepared to meet an attack from any direction at any time.

Any attempt to return to a narrow isolationist point of view will be a positive step to national suicide. Isolationism is not dead in our land—it is only dormant. As the approaching springtime of possible victory looms ahead of us, this sleeping bear is beginning to stir from hibernation. The inherent danger in the isolationist philosophy is apparent as we analyze the military strategy which has been used in this war. Both in war and peace our greatly increased global mobility has had a profound effect. The indication of things to come was given when Hitler outlined his policy of dividing his enemies and defeating each separately.

In the last war, we were careful to avoid pronounced salients. As quick as they were created the battle line was straightened either by additional lateral assaults or by strategic retreat. In this war, deep salients are driven on each side of a strong point and then it is isolated by destruction of its supply and communication lines. Its reduction is then more readily accomplished. The same policy has been applied to nations. The next time we isolate ourselves we are merely inviting aggression.

THE need for international coöperation was most eloquently expressed before the Council of the League of Nations on May 29, 1939, by the Right Honorable Stanley Bruce, High Commissioner for Australia, when he spoke as follows:

> The experience of the last twenty years has shown the growing extent to which the progress of civilization is dependent upon economic and human values. State politics are determined in increasing measure by such social and economic aims as the prevention of unemployment, the prevention of wild fluctuations in economic activity, the provision of better housing, the suppression and cure of disease. These matters, which affect the daily life of every man, woman, and child, are among the principal preoccupations of statesmen and politicians in all countries, whatever their political structure.
>
> Modern experience has also shown with increasing clearness that none of these problems can be entirely solved by purely national action. The need for interchange of experience and the coördination of action between national authorities has been proved useful and necessary, time after time, in every section of the economic and social fields. . .
>
> The world, for all its political severance, is growing daily closer-knit, its means of communications daily more rapid, its instruments for the spread of knowledge daily more efficient. At the same time, the constituent parts of the world, for all their diversity of political outlook, are growing in many respects more similar: agricultural states are becoming rapidly industrialized, industrial states are stimulating their agriculture. Nothing is more striking in this connection . . . than the swift industrial development of the great Asiatic countries.
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> These changes inevitably give rise to new problems that can only be solved by joint effort. Thus, trade and personal contacts are facilitated, but, simultaneously, economic depressions become more widespread, and, were there any relaxation of control, human and animal diseases would spread more widely and more rapidly. Neither the economic nor the physical contagion—nor, indeed, the moral—can be checked by national action alone, except by recourse to almost complete isolation.
>
> Indeed, to attempt such isolation is one of the first natural reactions to the more frequent and intenser impact of these world forces. But it reflects rather a blind instinct to ward off these impacts than a desire of the constituent parts of a changing world to adapt themselves to what in the long run must prove the irresistible dynamism of these changes; and there can be no development without adaptation.

ARE we living up to our present international obligations even when we have the impelling force of military necessity to goad us forward? While in India, I had the honor and pleasure of meeting and associating with the Chief of Ordnance of the Chinese Army. Educated at Harvard and M.I.T., he was the moving spirit who gathered together the machine tools of the industrial plants of China and transported them back to the underground arsenals of the Chinese hinterland. It is here, by an amazing and prodigious effort of industrial organization, that he has created the munitions-producing industry which has kept China in this war as our friendly ally.

My observation is that China has asked for little and has received less. Her casualty list has already far exceeded that of any other participant. She has been longer in this war. The eventual effect of those first shots at the Marco Polo Bridge will depend upon what we, here in the United States, do to assist now our staunch friends and allies, the Chinese. The western nations, by virtue of the ignominious defeats we have suffered in the Far East, have "lost face." The Stars and Stripes alone is the only western flag still greeted with enthusiasm in Chungking.

If we fail to capitalize upon the respect which has come to our men in arms in standing shoulder to shoulder with the Filipinos to defend their country; if we fail to keep our promise to assist China by every possible means, we may easily contribute to the fall of the unified government which has been created there. We may tip the lid of a Pandora's box which will unleash forces which may lead to the destruction of our western civilization.

While we freely examine and criticize ourselves, let us curb our temptation to criticize our allies and so conduct ourselves that we come to the peace table with clean hands, ready to lead, not to be led; ready to give, not to receive; ready, above all things, to use our might to assure that the world we live in afterward will truly be a better place for all people.

Our first duty, as citizens of this nation, is to make it our individual business to see that the people who will represent us at the peace conference shall be chosen from those who have accepted the duty call of our President and have risked their own lives to go out now and familiarize themselves with the true nature of these evil forces. Let us insist that they be men who know the miseries of war by personal experience and are still willing to serve the interests of the common man, regardless of race or creed.

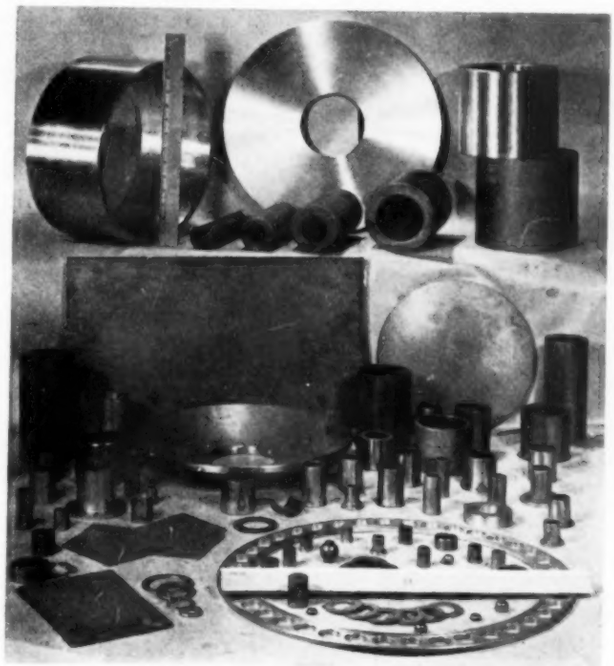
Powder Metallurgy

A New Process Forms Metal without Melting or Machining

Lieut. Col. J. H. Frye

A FEW years ago a finished oil-pump gear was shown to the executives of a large motor company and the statement was made that this part was probably the only iron or steel part in the world made from ore without melting and finished to a high degree of accuracy without the use of a cutting tool to shape or form the part in any manner.

In making this gear, the first step was the production of a finely divided iron powder made by deoxidizing Swedish ore with charcoal at about 1,600 degrees Fahrenheit. A "sponge iron" was obtained which was pulverized into powder in a ball mill. Then the powder was molded under pressure into the form of the gear and sintered at about 2,000 degrees Fahrenheit, well below the melting point of iron. The gear thus produced required no further machining, was highly finished, and was ready for assembly with other similar gears to form a quietly operating gear train.



BEARINGS AND OTHER PARTS MAY BE MADE IN MANY DIFFERENT SIZES FROM POWDERED METAL

This process was the basis for the further development of powder metallurgy and was a new approach to the problem of fabricating machine parts at low cost. It marked the start of a new method for the rapid duplication of finished parts. These parts may vary in density from porous filter plates to machine parts of high strength which could be produced by suitable variations in the material used and in the conditions of compression and subsequent sintering.

In recent years, the number of parts made by the processes of powder metallurgy has increased enormously. The fact that pure Swedish ore is no longer readily available has proved no obstacle to the development of the production of parts made from ferrous as well as nonferrous powders. The most extended developments, however, are in the field of iron powder metallurgy. The finely divided metal powders used in producing such parts are made by a number of different processes as explained below:

Reduction of ores.—This is the simplest process and consists of heating relatively pure oxide ores in the presence of a reducing agent at a temperature below the melting point of the metal so that a sponge-like, oxide-free mass is produced. This process is widely used in making sponge iron which is later ground to the requisite degree of fineness in a ball mill. The making of sponge iron by this method is of great antiquity and long preceded the reduction of iron ore in the blast furnace. Centuries ago, iron implements were made from sponge iron by heating the latter and hammering it into shape, but only recently has sponge iron been used in the processes of powder metallurgy.

Reduction of rolling-mill scale.—This process is similar to that used in ore reduction. It produces a powder containing less earthy residue or slag but contains the same alloying elements present in the original metal and correspondingly varies the character of the finished product. Both iron and copper powders are produced from rolling-mill scale.

Atomizing.—This process consists of spraying molten metal into a current of air or steam. It is used in making both nonferrous alloy and iron powders.

Electrolytic process.—In this process the metal is loosely deposited on the cathode and recovered in a very pure state. It is used for the production of copper and iron powder, especially when the latter is desired carbon-free and of high purity.

The carbonyl process.—This process involves the formation of a heavy liquid which is an unstable compound of iron and carbon monoxide. On decomposition of this compound, spheroids are built up of superimposed layers of extremely pure iron. This material, because of its purity, form, and physical structure, is of great importance in making electromagnetic parts.

Mechanical disintegration.—This method is particularly used for the production of powders from brittle metals such as bismuth and antimony, or alloys of copper and tin. It consists merely of mechanical disintegration to the desired size by use of suitable crushers.

THE important step in the manufacture of parts from metal powder is that which consists of sintering by heating a formed part at a suitable temperature (about 2,000 degrees Fahrenheit for iron) in a reducing atmosphere. To make an extremely porous part, such as a filter (usually made from a powdered bronze alloy), the powder is loosely placed in the mold and heated to the required temperature so that the

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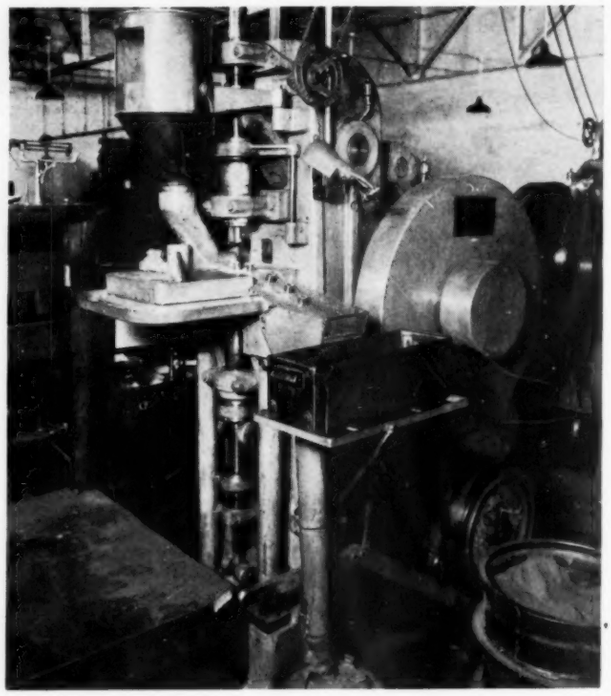
particles stick to each other. In this case there is little strength to the part, but the degree of porosity can be closely controlled by the particle size of the original powder and the conditions under which the sintering is performed. In this manner the most exacting technical requirements may be met.

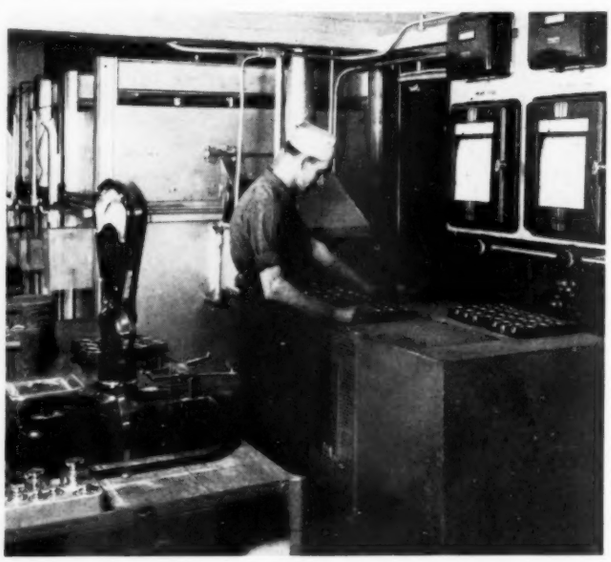
Most parts made from powdered metal, particularly parts made from iron powder, require considerable strength. In this case, compression precedes sintering. First, the correct amount of powder, measured either by volume or weight, is placed in a hardened steel die chamber. Then a close-fitting punch, operated either hydraulically or mechanically, compresses the powder at pressures usually varying from 40,000 to 100,000 pounds per square inch or 50 to 30 per cent of its original volume. After the punch has traveled its measured stroke, the motion is reversed, and simultaneously a similar punch, working from the opposite direction, pushes the pressed briquette from the die. As the briquette is ejected, it is swept from the plate of the machine into a box ready for removal to the sintering furnace. The operation of compressing lends itself to automatic functioning so that little attention is necessary except to keep the presses supplied with powder. As many as 200 parts a minute can be briquetted in a single press, and one operator may attend several presses.



An Automatic Briquetting Machine

Powder from the hopper is fed to the die cell, compressed, and the article ejected ready for sintering.

These briquettes are now ready for sintering and are laid on the belt of an automatic electric or gas furnace operating from 1,450 degrees Fahrenheit for bronze parts to as high as 2,050 degrees Fahrenheit for iron pieces. In the controlled atmosphere of this furnace, oxidation is prevented, and at the high temperature used the particles of metal are "knitted" together so that after some twenty minutes' exposure to the sintering heat and subsequent cooling to room temperature, the parts emerge with a bright, smooth finish and with reasonably high tensile strength. When great dimensional accuracy is necessary, the parts, after sintering, may be subjected to a cold-swaging operation which increases the strength and reduces variations in size.



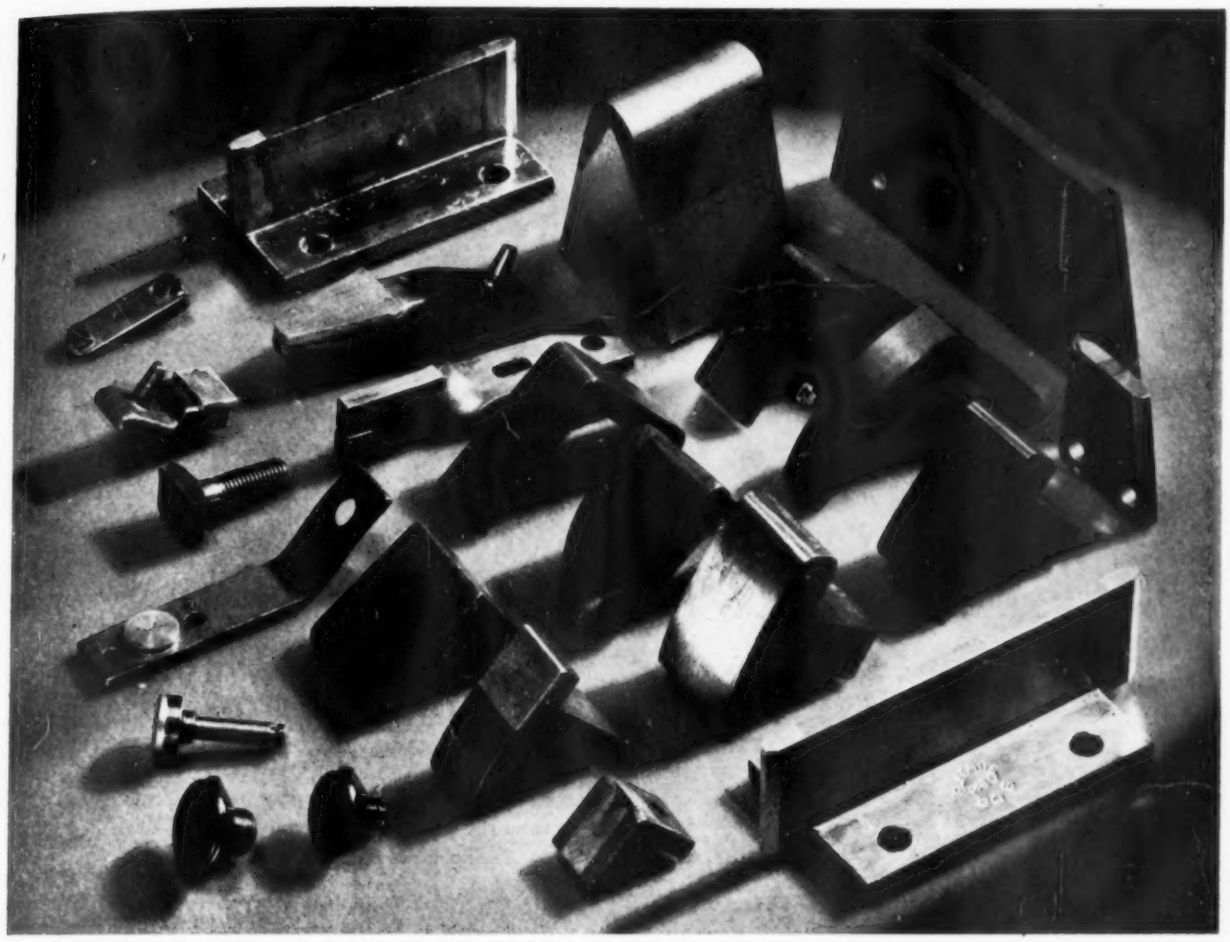
Briquetted Parts Are Placed on the Belt of a Controlled-Atmosphere Sintering Furnace

Porosity of the finished piece is controllable, varying with the degree of compression, the character of the powder, and the extent of the use of gas-forming additives which, in the sintering operation, develop interconnected capillary passages or pores. In the manufacture of bearings, close attention is given to the formation of such passages to definitely control the percentage of lubricant with which they may be impregnated. In such bearings, the lubricant is gradually fed to the rubbing surface and, under some conditions, may be sufficient to insure lubrication for the life of the machine. Under more severe operating conditions, additional lubricant may be supplied by conventional means, usually through the back wall of the bearing. In any case, these self-lubricating bearings supply sufficient wetting of the surface at the time of starting the machine to prevent damage until the regular lubricating system can begin to function. Instead of using a liquid lubricant, babbitt may be melted and impregnated into the bearing which, after solidification, provides a soft metal rubbing surface.

IN Ordnance, powdered metal is used in the following general types of equipment:

Friction surfaces.—In such parts, as the clutches of tanks and mobile artillery, suitable copper-tin-iron powders generally are brazed to a backing steel plate to provide necessary rigidity.

Bearings.—Such parts, made from either bronze or iron, or some combination of iron, copper, tin, and lead, are generally made slightly porous so that when impregnated with oil a continuous oil film separating bearing and journal may be maintained. Such bearings are very generally used. Main and connecting-rod bearings for tank engines, embodying a porous layer of powder metal brazed to a steel backing and then impregnated with babbitt are also widely used. In this construction, the babbitt is



COMPLETE ELECTRICAL CONTACTOR ASSEMBLIES WITH FACINGS OF BRIQUETTED COPPER POWDER

mechanically held in the pores of the powder-metal matrix with a lock-joint effect that prevents fatigue failure of the babbitt under high loading. Also, the surface coating of babbitt, two or three thousandths of an inch thick, provides a soft metal noncorroding surface against which the crankshaft operates with little wear.

Filters.—Using carefully controlled powder sizes, filters for fuel may be formed which, with low restriction rates, give very efficient separation of foreign particles from the fluid. Such filters are largely used in tank and airplane engines, particularly of the diesel type in which foreign matter could easily cause clogging of the injector nozzles.

Special parts of unique properties.—Early interest in powder metallurgy was developed because this process offered an opportunity to form metals, such as platinum and tungsten, into parts which could be made by other processes only with great difficulty. This method is used to make tungsten filaments for automotive-vehicle bulbs and to form switch points of high-melting-temperature materials. Alnico and similar magnets, composed of aluminum, nickel, and cobalt, with magnetic properties far beyond those commonly available, are also made from powder metals. Tungsten-carbide tools which have revolutionized old concepts of machining time, are made from powdered-metal briquettes. Wartime developments have called for a wide usage of electrical-resistance parts made from powdered steatite (talc) with dielectric and dimensional qualities unobtainable by other processes.

Mechanical parts.—This is one of the fields in which powder metals are most widely used. Naturally, this use is being built around ferrous powders because of the higher costs and limited supply of the nonferrous metals. Adequate sources of iron powder and high-temperature continuous furnaces necessary for economical operation are now available. A vast amount of study and experiment has been built into the art in order to produce parts having the necessary physical properties.

IT is of prime importance that parts should be made with properties adapted for the particular use to which they are intended. Merely to specify that a part is to be made from "powdered iron" is not sufficient and inevitably leads to wide variations in the properties obtained.

To insure uniformity of physical characteristics irrespective of the parts manufactured or the variable powder conditions and methods of production, the Ordnance Department is preparing a basic specification for mechanical parts made by powder metallurgy. It is not the intention to specify the powder or the procedure of manufacture of the parts. It is intended to establish a floor under the quality of the finished parts. It is expected that the specification will contain several classes or grades, differentiated by increasing tensile and elongation requirements. Only by this method can the Ordnance Department use powder-metal parts obtained on a competitive basis and yet permit the necessary freedom of production practices required by the manufacturers.

New Ordnance Matériel

No enemy tank can survive a direct hit from the 3-inch high-velocity antitank gun shown above mounted in the Army's new tank destroyer M10, which also carries a cal. .50 machine gun in its open-top turret. Extra armor plates may be attached to the sides. In the official Army photo below are the new 3-inch mobile antitank gun and the 37-mm. weapon.

The Amphibious Jeep

New addition to the Army's reconnaissance vehicles, the amphibious jeep is equally at home on land or water and is not dependent on bridges or fords to reach its objective. Shown above is a fleet of the new cars plowing through the River Rouge while, below, one emerges from the water ready to travel overland. An amphibious jeep trailer is in mass production.

Mechanized Ammunition Manufacture

New Machines Are Developed by Picatinny Arsenal and Industry

Col. William E. Larned

IT has always been the dream of design and production engineers, both military and civilian, to convert manual operations to machine operations, and the urge has been particularly great in ammunition due to the vital importance of the product and the enormous quantities involved. Small-arms ammunition has become almost completely "mechanized" in its manufacture, and the problem here has been relatively simple due to few types and long standardization of these types. Artillery ammunition in all its ramifications of metal parts, fuzes, shells, cases, primers, boosters, detonators, fillers, and all the other various items that are essential to its functioning, presents a highly complex and involved picture which is further complicated by the changing types demanded by the constantly shifting technique of warfare and the bitter effort to keep one jump ahead of the enemy. It is only in the well-standardized fundamentals that mechanization of artillery ammunition, bombs, and pyrotechnics can be effected.

THIS article on recent developments in machinery to speed up our artillery ammunition production is a tribute to the coöperation between the Ordnance Department of the Army and private industry. Colonel Larned, the author, frankly states that neither Picatinny Arsenal—the Army's great ammunition manufactory—nor private industry often made an entirely satisfactory machine without the help of the other. Working together, outstanding results have been, and are being, achieved.

Obviously, many commercial concerns besides those mentioned in this article contributed to the development of new and better ammunition machinery, but lack of space prohibits listing them all. Only salient types of machines or those that presented particularly unique problems are discussed herein. But the name of every company who aided this cause is known and remembered by the Ordnance Department, and all are looked upon as the Army's staunch and dependable allies in the vital battle of production.—EDITOR.

For years, Picatinny Arsenal has been working on all kinds of machines to eliminate hand operations. Such elimination is particularly desirable in ammunition wherever possible, since it does away with the personal factor, gives uniform results, is much more economical, and facilitates mass production. Prior to the present emergency, many machines were built and were partially successful, but many remained uncompleted due to lack of funds or facilities. Other machines existed in the minds of engineers or had reached completion on the drawing board only; but some of these drawings have served as the pattern for successful machines now in universal operation. The experience gained by these continuous efforts to develop machines has been of inestimable value to the commercial concerns which have since stepped in with their engineers and organizations to work with Picatinny Arsenal toward the practical completion of machines necessitated by the pressure of war.

In the early stages of the emergency, when Picatinny Arsenal was practically the only source of ammunition larger than small-arms ammunition and when requirements and types were ballooning almost weekly, the pressure for increased production was terrific and continued to increase in direct ratio to demands, the arsenal's ever-thinning supervisory personnel, and the inability to process even untrained personnel in sufficient numbers to keep up with required schedules. The simple hand fixtures and machines in use gave way to pneumatic, hydraulic, or mechanical equipment of commercial design which could be adapted to this work. This threw the emphasis on tools, jigs, and fixtures since they wore out much quicker under the greatly increased and heavier usage. The problem got beyond the ability of the arsenal to handle in its own shops, and an attempt was made to procure through the regular procurement methods. Chaos resulted, and much time and effort were lost.

The problem was solved by interesting the necessary number of local shops in the production of equipment to which their facilities were adapted until all needed equipment was covered. In this way, not only was Picatinny Arsenal supplied, but these concerns were ready to produce similar equipment in quantity when demand arose from other contractors and plants or to assist other firms in producing like equipment. Close coöperation of these concerns with the arsenal resulted in great improvement in the quality of tools, jigs, and fixtures and their increased life which was so essential when toolmakers were practically nonexistent. Some of the concerns which rendered valuable service along these lines were Magnus Tool & Die Company, Reliable Tool & Die Company, C. B. Christiansen Company, Triad Tool & Die Company, all of New Jersey, and the Unique Specialties Company and the Bennel Company of New York.

SUCH simple changes, however, were not enough. Vanishing space and equipment practically forced the issue of machines. To simplify and hasten procurement, it was decided to contract both the design and development of the machines needed. The most outstanding difficulty first encountered by the arsenal was that of finding a commercial concern willing to undertake the complications and uncertainties of this type of work. Due to its preoccupation to the saturation point along other lines, it was manifestly impossible for the arsenal to try to build these machines. Commercial concerns shied away for several reasons: there

Colonel Larned is the Commanding Officer of Picatinny Arsenal. Established in 1880, Picatinny was largely developed during World War I. The new plant, built since 1926, constitutes an up-to-date explosives and ammunition laboratory and manufacturing facility.

was uncertainty as to the market for such equipment, the work was highly specialized in a totally unfamiliar field, and the "stigma" attached to the manufacture of munitions had not been completely eliminated. There were many concerns, however, which had developed heavy production machinery for the automotive and other trades, and no difficulty was experienced in obtaining the coöperation of such companies in modifying this equipment to adapt it to the manufacture of ammunition.

Such machines as Cleveland, National, and Davenport automatics, Kingsbury drilling machines, Waterbury Farrel, and Henry & Wright machines, and many others are types in question and have become almost household names. All these companies and many others cooperated with Picatinny Arsenal to the fullest in meeting our adaptation requirements, and this preliminary work undoubtedly laid the foundation for the existence in quantity of these essential machines when production demands overflowed to commercial concerns and new Government-owned plants.

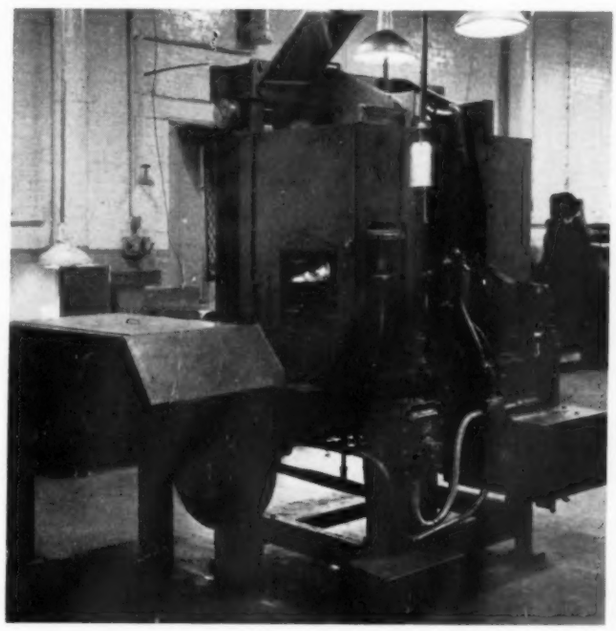


FIG. 1. R. A. JONES DETONATOR-LOADING MACHINE

One of the first machines to reach completion under the pressure of the emergency was the explosion-proof truck. Safety regulations had forbidden anything but the use of hand trucks in moving ammunition containing explosives in any stage of manufacture. Hand methods bogged down, however, when it came to mass production, and something had to be done. This truck was pioneered by the Yale & Towne Company, and its close collaboration with Picatinny engineers developed a truck that satisfied safety requirements and opened the way for the necessary changes in regulations. This truck is a common sight in Ordnance loading plants and its economy over the hand truck is obvious.

SINCE several detonators may be used in a single fuze, the demand for this item reached astronomical proportions, and a machine to hasten production was one of the first considerations. The history of its development is perhaps typical of the difficulties that were encountered in any effort to develop machines that had to deal with explosives, particularly sensitive explosives like lead azide, primer mixture, and, to a lesser degree, tetryl and TNT. Drawing up a contract was the first stumbling block. Since no similar machines had ever been made, it was impossible to write complete specifications, and those that were written had to be modified. Acceptance-test requirements were based on theory, since all the arsenal knew were its own requirements, and there was no means of judging the capacity of a machine yet to be made. These requirements also had to be modified.

The development of the machine was undertaken by the Canister Company of New Jersey. However, in line with the manufacturer's experience, it was constructed to handle inert materials rather than explosives, and, as a result, it did not meet the safety requirements of the arsenal despite the time, money, and efforts so generously expended by the company. The experience gained, however, was worth the cost of the failure. Certain fundamental requirements became obvious and admitted of no compromise. Some of these were: simplicity, positive indexing, safety switches—either electrical or mechanical—to stop the machine the instant anything went wrong, the continuous elimination of explosive dust by vacuum or other means, proper barricades at dangerous places for the protection of operating personnel, hoppers with feeding mechanisms that would absolutely insure proper positioning of each item, continuous flow, and no more or less than the required number of items, shielding of moving parts from any possibility of explosive-dust accumulation, and many others.

After the first effort, the development of the machine lay dormant from lack of volunteers until R. A. Jones, head of R. A. Jones & Company, makers of automatic machinery in Ohio, appeared and asked for something to do to help the war effort; he was offered the task of making this long-sought machine. He agreed to undertake the development, patriotically insisting on no payment if the machine did not work. Unfortunately, Mr. Jones died before he could see the successful completion of probably one of the most difficult developments in ammunition-loading machines. However, his son carried on the work and was undoubtedly greatly assisted by the arsenal's recently acquired experience. Close liaison with the arsenal all through the development unquestionably saved many errors, much time and money. Even when completed, the machine (Fig. 1) underwent numerous changes made right at the arsenal by Mr. Jones and his chief engineers who gave unstintingly of their time—staying with the machine and operating it under exact service conditions until all the difficulties were removed. It was their tenacity and zeal that finally brought success. New machines embodying all the latest features are now under order for the arsenal, and more are being built for loading plants.

As a gauge of the efficiency of this machine, 6 operators can make the necessary preparations and can load 8,000 detonators per 8-hour shift as against 17 to 20 operators loading 7,500 detonators in the same time. Floor space of the machine is 6 by 6 by 7 feet, whereas the hand-operated line requires 20 by 50 feet.

The complexity of this machine is indicated by the following series of operations it must perform: Tetryl pellets are loaded in a feed tube by hand, and this tube is put in place; lead azide or mercury fulminate is volumetrically

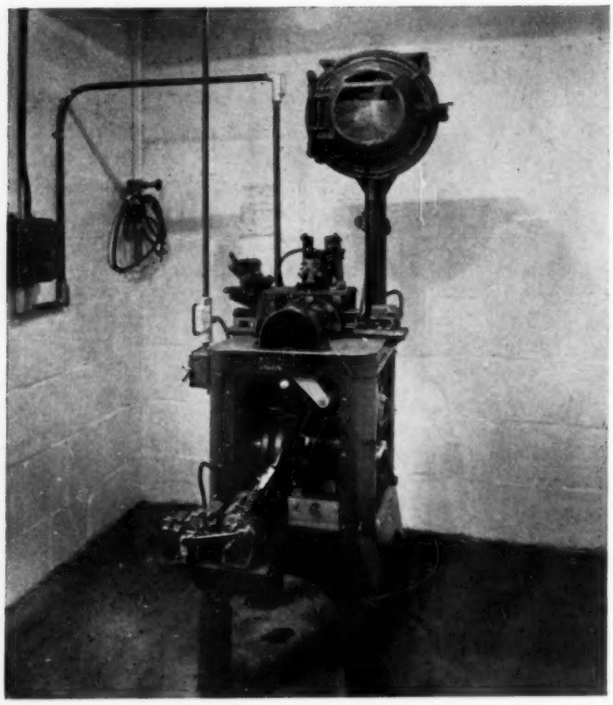


FIG. 2. ALUMINUM SEAL COMPANY DISK-INSERTING MACHINE

measured and fed manually; the detonator cups are hopper-fed. With raw materials assured as above, the steps are: (1) A detonator cup slides down from the hopper to be released. (2) The cup is tripped to the correct position. (3) An arm slides the cup forward. (4) A chuck forces the cup into a sleeve on the turntable. (5) At the next station, the cup is gaged. A short cup, an inverted cup, no cup, or a cup with a malformed top will automatically stop the machine. The cup is removed by hand and another is inserted. In the case of "no cup" a cup is inserted. (6) A tin-foil disk for the bottom of the cup is punched and seated in one process. (7) The cup is gaged for "high cup." If the cup is too high or too long the machine will stop automatically, the cup is removed, and a proper-sized cup replaced. (8) An operator measures a level scoop of explosive and pours it into the cup. The process inspector performs a ten per cent test of the scoop every hour. (9) The charge is consolidated under a spring-loaded press to a predetermined pressure. (10) One tetryl pellet is fed into the cup from the tube. (11) The charge is consolidated to a fixed height that will produce a definite over-all length after crimping. (12) The cup is closed with a disk of colored tin foil which is punched and deposited from a roll. (13) The cup is crimped at a 45-degree angle, excess powder removed, and then flat-crimped. (14) The completed detonator is lifted from the sleeve by a finger and knocked out. (15) An operator removes the detonators from the chute and boxes them. (16) Another operator performs a one hundred per cent inspection test and trays the detonators.

THE mechanical sensing devices provide for an exceptional degree of safety in that not a single blow was experienced in loading the first hundred thousand detonators, whereas blows occur frequently on hand-operated lines.

While the development of automatic detonator-loading machines was in progress by private industry, Picatinny Arsenal was also developing presses for detonator loading. The press in use at the time was a manually operated one of commercial design but was not satisfactory from many angles. The line of development proceeded from hand to hydraulic operation, then to pneumatic-operated beam presses, and finally to the pneumatic machines now in universal use in all loading plants. This press development was purely a Picatinny affair, and the final development produced a superior press for a definite purpose. The detonator-loading line is equipped with five of these—two reconsolidation, two crimping, and one extracting press.

The original method of loading primer detonators consisted of compressing the tetryl pellet first and then loading and compressing the sensitive explosive. With this method, each time a blow occurred it practically wrecked the machine and tools as the full detonator exploded. The idea of loading the sensitive mixture first was conceived and tried out. It was found practical to load in this manner, and when a blow did occur, very little damage resulted. This change in loading methods required a redesign of the component, as it was impractical to manufacture a cup having thick side walls and a thin bottom.

The cup was made as usual, the bottom punched out, and a thin disk inserted in the bottom. This method had its difficulties—the principal one being inserting and keeping the disk in the bottom of the cup. It was necessary to measure the thickness of each disk with a micrometer immediately before insertion to assure that only one disk was being inserted. After that, it was necessary to handle these cups very, very carefully in carrying them from one operation to another, as the least jar or jolt would either loosen the disk and cause a reject for a dirty bottom due to the explosives being forced out or knock the disk out altogether.

Considerable experimentation was carried on to produce an automatic machine for punching and seating the disk in the cup prior to loading. Authority was obtained to use a cement for retaining the disk in place after it had been

FIG. 3. CONSOLIDATED ROTARY PRIMER-CHARGING MACHINE

assembled. The Jones detonator-loading machine described above punches and seats the disk and loads the detonator without cementing the disk, the consolidation of the explosive holding the disk in. The Aluminum Seal Company, in conjunction with Picatinny Arsenal, has developed a machine for automatically assembling this disk, cementing it in place, and inspecting it under a vacuum to assure that it is properly seated (Fig. 2). The Consolidated Packaging Machinery Company also has developed a similar machine except that the inspection has been omitted. This disk is cemented with shellac in the operation. Each of these machines will produce about 30,000 cups every 8 hours and will replace approximately 26 operators.

Artillery primers have long offered a tempting field for mechanization and a perpetual challenge to the inventive engineer. The first successful machine evolved was designed and built at Picatinny Arsenal about 1937 and was a rotary charging machine which automatically measured and inserted the black-powder charge in primer bodies. The pioneer machine was naturally full of "bugs," and, as the demand was great and the arsenal had no time to either redesign or make them, the work was turned over to the Consolidated Packaging Machinery Corporation, and the final method was evolved. Primers are inserted manually, and the machine is easily adjustable for varying both the charge and length of primer. Its production is approximately 1,500 primers an hour. The net result is greater uniformity and reliability, and the saving in personnel and space is obvious. The machine, shown in Fig. 3, is widely used in loading plants.

HAVING successfully solved one primer problem, the arsenal was encouraged to tackle perhaps the most difficult primer problem of all—the simple insertion of a paper liner in the primer body. This operation was being performed manually, and, as the requirement of primers was almost as astronomical as that of detonators, the amount of personnel, time, space, and expense needed to place that small roll of paper was almost as astronomical as the requirements. The purpose of the liner is to prevent the outside waterproofing compound from running through the flash holes and contaminating the black-powder charge. A wooden mandrel was used; the paper, cut to size, was rolled on the mandrel and inserted in the body. The paper on release would then expand to the side wall of the primer and the mandrel was removed.

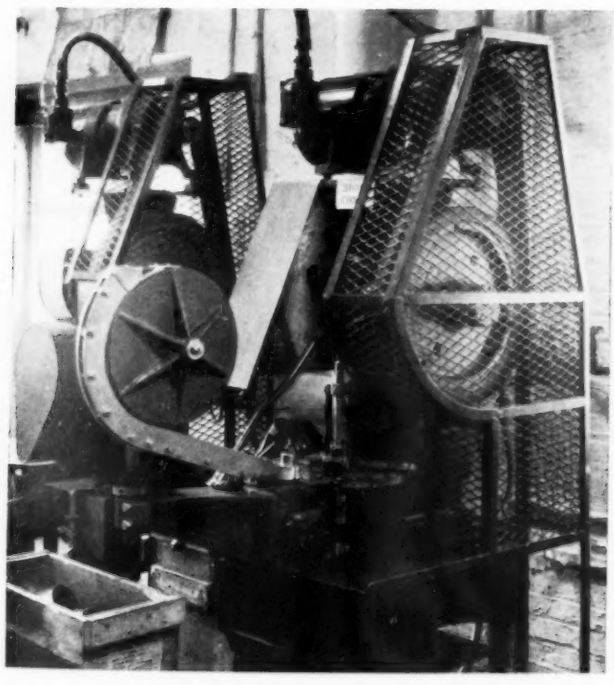


FIG. 4. A DOUBLE-BEAM PRESS WITH HOPPER FEED

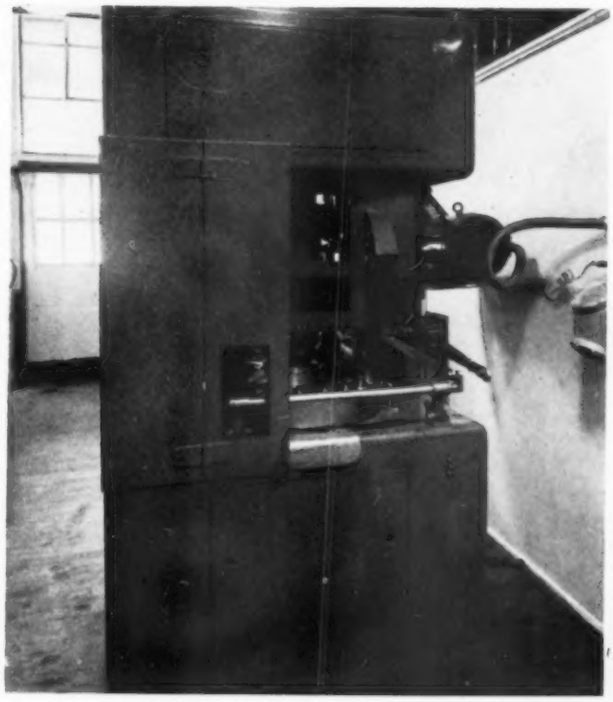


FIG. 5. CONSOLIDATED PRIMER-ASSEMBLING MACHINE

Simple as the operation appeared, and although an attempt was made more than five years ago by Picatinny to develop such a machine, it was only recently that the Waterbury Farrel Foundry and Machine Company of Connecticut brought the development to a successful completion. Now one operator using this machine (Fig. 6) can insert almost 20,000 liners in 8 hours, and a great saving in floor space has been effected. Well-deserved recognition should go to the Waterbury Farrel Company for this work—not only because of its successful completion but also because they released all rights to the machine and permitted the use of their drawings for its procurement from other sources. Many of these machines are in use in loading plants.

The artillery-primer machines described apply to the primer body, but one unit of the complete primer, the head, had yet to be dealt with. The primer head consists of a firing pin or anvil, a primer, and a primer-head body which, when assembled, constitute the primer head. The primer head assembled to the primer body eventually makes the complete artillery primer. The Waterbury Farrel Company developed three machines to assemble the head. The first machine sorted and loaded the primers in a tray, the second sorted and loaded the anvils in a tray, and the third machine, which was a straight-line affair, accepted the components from the two trays, hopper fed the head body, and completed the assembly.

The machine was a success, but the design of the primer

head was changed to such an extent as to require further development. The Waterbury Farrel Company, being preoccupied with other work, was unable to continue, and the Pennsylvania Machinery Company, a subsidiary of the Standard Pressed Steel Company, undertook the job. They produced a rotary-type dial machine equipped with hoppers for feeding the parts to the dial, except for the primer-head body which is fed by hand. Inspection stations have been added to stop the machine if any of the parts are omitted or if the assembly is over length. A production of 30,000 assemblies every 8 hours with 25 less operators than are required for the manual method is possible. Floor space has been reduced ninety per cent.

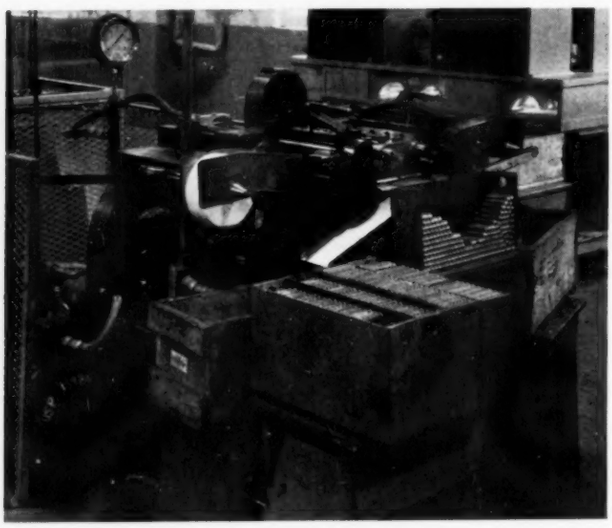


FIG. 6. WATERBURY FARREL LINER-INSERTING MACHINE

HAVING developed machines to insert a liner in the body, another to charge the body, and still another to assemble the head, the next logical step was a machine to assemble head and body. This involved several operations, such as inspection of height of charge, luting the head assembly with asphaltum paint, assembly to the body at a predetermined tension, and, finally, staking head to body. The successful development of this machine was accomplished by the Consolidated Packaging Machinery Company. The machine (Fig. 5) requires the full time of three operators and will produce from thirty-five to fifty primers a minute as against a requirement of eight to ten manual operators for an equal production. Floor space in this instance is a tremendous factor. Some or all of the above machines for the loading of artillery primers are widely used in loading plants. The machine development cycle for the artillery primer had been completed!

There are many operations in the loading of artillery ammunition which require the reconsolidation of small explosive charges which were previously pressed in the form of a pellet prior to assembly in the component. Cases in point are booster closing cups and relay and delay charges. Much consideration and time were given to a machine which, it was thought, could be used universally for this type of operation. The final outcome was a double-beam rotary-type punch press with a capacity approximately the same as a Bliss No. 18 press. The principal feature of this machine was the two stations on which the load was controlled by a scale beam similar to the ones used by the Olsen or Riehle bench-type platen presses.

These machines were designed at Picatinny Arsenal and were originally built and developed by the F. L. Smithe Company of New York, Machinery Builders of Long Island City, and the Detroit Tool and Die Company of Michigan. The machines operated exceptionally well, and the demand for this type was far beyond any expectations in that they were used on all kinds of work which was never anticipated. For instance, they have been used for stamping operations to such an extent that hopper feeds have been designed and assembled to some of the machines (Fig. 4). They were used for staking and crimping operations so extensively that a contract was given the McKiernan Terry Corporation for the development of a pneumatic staking machine, of which 1,000 or more have been built.

These double-beam dial presses were rather expensive, and the demand was excessive; therefore a survey was conducted to determine to what extent full use was being made of the double-beam principle. It was found that the double-beam facility was being fully used on only approximately five per cent of the installations. Consequently, a contract was placed with the Bliss Company of New York, the Jno. Verduin Company and the Sipp-Eastwood Company of New Jersey for the design and manufacture of single-beam dial-operated presses. These three companies have designed and built many satisfactory presses of this type for the contracting companies.

The double-beam presses previously referred to were without feeding mechanisms and often required from two to four operators seated around the machine to feed components and pellets at the proper stations. One such operation was the loading of booster-lead or booster-closing cups. This operation required feeding the cup, feeding and compressing one pellet, feeding a second pellet, and final compression. Commercial concerns as well as Picatinny Arsenal were reluctant to accept responsibility for the development of suitable equipment to sort and feed these pellets. The difficulty is due to the breaking up and dusting of the pellets. If the dust is not confined, it creates an exceptional health hazard; if confined, it creates an explosive hazard. R. A. Jones & Company has designed and built a machine for automatically feeding and loading one of these booster cups. The pellet-feeding mechanism has been developed from the one used on their detonator-loading machine, and the dust hazard has been removed by a vacuum system designed and built for this particular operation by the New Jersey Machinery Corporation. This machine will completely load approximately 24,000 units each 8-hour shift.

IN order to handle and control more efficiently and speedily the small quantities of sensitive explosives of various types that play such an essential rôle in the functioning of artillery ammunition, such as primers, detonators, boosters, delay elements, etc., it has long been the practice to press these explosives into pellet form before consolidating them into the little cavities and cups located within the delicate mechanisms. The same type machine has been used as is employed to make pills, candy, and many other commercially used pelleted forms, and pellets can be made from pencil-lead diameter up to several inches. Under the urge of necessity, these machines have undergone transformation and modification to deal more safely and quickly with a tremendously increased rate of production. From single-operated presses has come the rotary press which pours out

pellets in any size or shape in a continuous stream just so long as the materials are fed to it. The close coöperation of the F. J. Stokes Machine Company of Pennsylvania with Picatinny Arsenal has developed many of these improvements, and their presses and similar ones are universally used in our loading plants.

Specialized pelleting machines have been developed for specific purposes. For example, pellets for some boosters previously were made on a rotary-type pelleting machine and assembled to the booster cup manually. This operation was very slow and, in addition, presented quite a health hazard. The handling of the tetryl pellets alone was considered a toxic operation, and this hazard was greatly increased due to dust formation on the pellet from handling, this dust being dispersed in the atmosphere when the pellet was forced into the cup. Much consideration was given to some method whereby these pellets could be mechanically sorted and assembled to the cups. However, each method considered was found unsuitable for either one or more of the following reasons: (1) Breaking up or dusting of the pellet; (2) Inability to properly position the pellet, as the bottom circular edge was made with a radius to conform to the bottom of the booster cup; (3) The over-all length was considerably less than the diameter.

This problem was finally delegated to the F. J. Stokes Machine Company, which, with the assistance of arsenal personnel, produced an exceptionally satisfactory machine (Fig. 7). The machine is a special 14-station rotary-type pelleting press and is being used for making and inserting the pellets in the booster cups. The entire operation is automatic and operates at a speed of seventy-five units a minute, which could be increased if production requirements demanded. This machine accurately measures the quantity of tetryl and presses it to the required density. Both weight and density are held well within the limits specified. A star wheel carries the pellets to a rotating head of which the "pick-up" fingers deposit the pellets into the booster cup. The entire arrangement is smooth-running, and the timing is such that, with only a few thousandths of an inch clearance between the pellet and cup diameters, the pellets are accurately placed in the cups. The cups are then discharged on a tray, and when the tray is filled the operator removes it and replaces it with an empty tray. The cups are fed to the machine by means of a conveyor belt which is loaded outside a barricade. The machine may be adapted for any other booster of similar shape or size.

IN the assembly of booster pellets to the cups it is required that a cushion consisting of either paper or felt be assembled between the inside bottom of the booster cup and the pellet. These cushions were formerly punched out in a remote shop, delivered to the loading building, and assembled to the cup by hand. In order to keep up with the machine assembly of booster and cup just described, the Johnson Machine Works of New York has developed a machine for automatically feeding the cups, blanking and inserting the disk, and discharging the completed unit to a component tray. The cups are fed from a hopper to a rotating dial. As they pass under the proper station, the disk of either paper or felt is punched out from strip material and deposited in the cup. Production from this machine is approximately 9,000 units an hour, and only one operator is required to attend the machine. The floor space required is approximately five by three by six feet, whereas by previous hand methods approximately eight operators were required, and a complete room was used. This machine was procured for assembling the disks to a specific booster; however, it may be adapted to assemble any unit by changing the feeding mechanism and by replacing the punch and die with those of the required size for the component being assembled.

THE principal development work at Picatinny Arsenal prior to the present emergency was directed mainly toward equipment of general application in order to get maximum

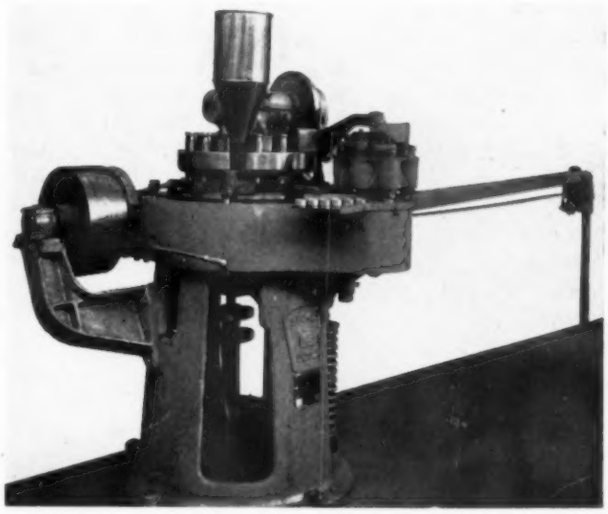


FIG. 7. F. J. STOKES ROTARY PELLETING PRESS

results from a single machine; however, numerous single-purpose machines have been developed. A few of these machines are still in use at this arsenal, some are in stores, others have been declared surplus, and still others have been either partially or completely salvaged and used in additional development work. Some machines have been either sold or leased to contracting loading agencies, but many of the machines being used by the contractor-operated loading plants are duplicates of those designed and developed by Picatinny, while many others are machines which have been improved from these designs. It may be stated here that few developments made by either Picatinny Arsenal or commercial concerns alone were ever entirely satisfactory. In every instance, the design and development required the full coöperation of the arsenal personnel with the machine builders to produce a well-balanced machine.

With all the time, ingenuity, and thought given by Picatinny Arsenal and other agencies to specialized machinery, by far the greater bulk of machines, tools, and equipment is standard commercial material, and it is well that this is true since such material is more readily available. Minor adaptations are necessary, and frequently special tools and jigs are required, but the basic machine or equipment remains unchanged.

The improvement in production methods, however, goes on and on unceasingly and is a constant challenge to all concerned, from the lowliest worker to the highest-paid specialist. Many new ideas are constantly being submitted and tried out, and frequently one "rings the bell" and is put to immediate use. Picatinny personnel have been doing this very thing for years and will continue to do so as long as there is a need for ammunition.

Balanced Production for War

Industrial Adjustments and New Techniques Insure Maximum Output

Howard Bruce

PRODUCING the implements and equipment to meet the demands of World War II is the most stupendous undertaking the world has ever seen. It reaches into every nook and corner of this country. It starts with the digging of raw material from the earth; extracting materials from the air and from the sea; bringing lumber from the forests; producing basic products from the soil; and processing these materials, step by step, into literally hundreds of thousands of end items. These include every single thing the ingenuity of man can conceive as being helpful to the creation of what we intend to make the greatest war machine the world has ever seen. The magnitude of the undertaking is indicated by the fact that the War Department alone is purchasing 500,000 items from 110,000 prime contractors and 900,000 subcontractors.

In the creation of this machine, time is the most valuable war material we use. The time we can save will be reflected in the saving of human lives, in the saving of untold national wealth, and in the lessening of the after-war dislocation of our economy and our lives.

Through 1941 our nation's production, our creation of useful, usable things, was increasing, but we were still far from the peak of productive capacity. And we were still arguing among ourselves; we were preparing for war, helping the allies through Lend-Lease, and trying at the same time to hold on to our normal way of life. War has to come close before self-interest and the natural desire for a comfortable way of life, with all its conveniences, are set to one side and fully replaced by patriotism and the primeval instincts of self-preservation. December 7th and Pearl Harbor changed this attitude. Overnight the nation was prepared to go all-out in its war effort.

The production accomplishment rising from month to month down to this day shows the immediate and sustained result of the change from thinking of war as a possibility, or even a probability, to having war at our doorstep. Along with the rising production of end items, there was a rapid increase in the construction of facilities, and, naturally, there was constant competition between production requirements and facilities requirements. We had our difficulties in securing tools; we had our struggles over items of materials—not so much because of an over-all scarcity but due to faulty distribution—and, of course, we had our continual headaches over priorities; but we were not thinking much of reaching the very limit of the supply of raw materials. Who would have thought, early in 1942, that lumber would become a critically short material and that we would find ourselves substituting brick structures to save lumber?

This expanding of facilities will, to some degree, continue as long as the war lasts. Some new facilities, largely in the shape of extensions, will be needed for new products and for bringing old industries into balance. But it is safe to say that the broad program of creating new production capacity is over the peak, that we have enough industrial capacity to utilize the present available supply of raw materials, and that we have moved into another phase. There will be for a time terrific pressure for the creation of facilities for the production of a few vitally important products, but our prime effort from now on will be devoted to making our materials go further and in trying so to distribute them as to get the maximum balanced production.

Maj. Gen. Lucius D. Clay, Assistant Chief of Staff for Matériel, has defined "balance" with great clarity as follows:

> Recent progress reports have repeatedly referred to balance. Actually there are four kinds of balance: Over-all balance, bringing total demand within the limits of total supply, is a problem of determining civilian, export, and military requirements, and it is only quite recently that the limits of the over-all program have been outlined. Secondly, balance within the military program itself, blending the requirements of the Army, Air Corps, Navy, and Maritime Commission, is determined by the Joint Chiefs of Staff with the aim of providing the maximum potential impact on the enemy. Thirdly, there is balance within the programs of each service—military requirements are not rigid but are influenced by strategic considerations, the topography of the theater of operations, and the potentialities of production. Fourthly, the components entering into a single end item must be balanced.

WAR is so fluid, is so continually changing and shifting its requirements of material, that every statement is subject to qualification, so I will say it is believed the present war program is reasonably within the raw-material supply. At any rate, the program has been cut back in the effort to make it possible from a material standpoint. Omitting certain specific projects of strategic importance, the war production problems of 1943 are primarily concerned with the balance of raw material, standard products, man power, and facilities. The order of preference of these various types of balance would have been different in 1942.

Most informed persons are generally familiar with the evolution of the priority system. As material or material distribution became so competitive and so confused between agencies and industries, someone described a high priority rating as a "hunting license." At any rate, in the middle of 1942 the priority system was superseded by the Production Requirements Plan which was an effort to bring allocations within the visible supply. This system had its defects and recently has been supplanted by the War Production Board's Controlled Materials Plan. Under this plan, the claimant agencies will submit to W.P.B. their requirements of the three controlled critical materials broken down into size and shape. From this computation of over-all requirements, an allotment will be made to each agency, the sum of such allotments being brought within the available supply. The agency will then allot to prime producers who in turn will

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Mr. Bruce, well-known Maryland industrialist and financier, is Director of Production Scheduling, Army Service Forces. Mr. Bruce was general manager of the Bartlett Hayward Company from 1909 to 1917 when he assumed the office of president which he held until 1928, becoming chairman of the board in that year and serving in that position until 1933.

Signal Corps

BOMBERS, TANKS, AND GUNS—INTRICATE FACTORS IN BALANCED PRODUCTION

pass the material on to their subcontractors. Again quoting General Clay: "Thus there will be a centralized control of materials with a decentralized flow of operations which will permit full utilization of industry's scheduling experience and personnel. The maintenance of schedules under this plan should be relatively easy of accomplishment in 1943."

This sounds practically perfect, and it would be if the war and its need of material would follow a fixed pattern; but it never has, and it never will.

The question of proper distribution or proper balance of standard products is a very critical one at the present time. These components are not normally procured by the Government but are purchased by its prime contractors and subcontractors and include such items as valves, pumps, compressors, dynamotors, fuel injectors, motors, electric instruments, and many other items of a similar nature. The War Production Board is undertaking special studies in cooperation with the claimant agencies to determine the overall requirements for these common components, to direct the placing of orders to develop maximum output from existing facilities, and to provide such additional facilities as may be necessary at the earliest possible date.

The distribution of available man power is just as real a problem as the distribution of materials. We must try to balance our supply so as to achieve the maximum war program. The shortage of human beings is going to be worse as the year passes. It must be met by drawing more heavily from the so-called nonessential industries, by bringing into industry more women, and by the employment of more men and women, both older and younger, than would normally be considered employable. Finally, we must find ways and means to get more out of a man-hour. As a practical matter, we will struggle with this question in individual localities and in individual plants.

THIS mechanized war is going to be won by the side with the best equipment and the most plentiful supplies. I purposely put best first. I think I can say the first tenet of the Army creed is: "We must make the best." The wisdom of this has been proved in every combat zone.

Many of the products of a few years back are obsolete. Many we are now making are likely to become obsolete. The Army recognizes that it is its job to bring to bear on this problem all the scientific knowledge in this country in an effort to produce the most effective products. General Campbell, Chief of Ordnance, has attached to his office a group of advisers. General Barnes, chief of the Ordnance Technical Division, has associated with him a long list of specialists on the many lines of ordnance. A visit to the Aberdeen Proving Ground gives one the impression that it is a mammoth research laboratory.

The same intensive struggle to produce the best equipment is going on in every branch of the Army. All this means change, substitution, and trying to bring into production the newer and better product without too much sacrifice of production in existing lines. In the final analysis, there is constantly going on a compromise between quality and quantity. Changes in requirements of combat troops affect schedules. The enemy has a vote on where, when, and how we fight.

Along with the effort to bring about a balance of the supply and distribution of valuable materials, there is an intensive effort to conserve such materials. Conservation takes many forms in saving critical materials, labor, machine-hours, and shipping space. The Ordnance Department, in an effort to accelerate its campaign for conservation, has established a conservation and substitution unit in each of its district offices as well as a screening organization in Washington to pass upon the suggestions submitted either directly

or through the Ordnance districts. By publications and information of every form, they stimulate the flow of suggestions from manufacturers and from the Ordnance staff itself. As a result of this system, in recent months a flood of suggestions has been submitted. Of those reviewed, over fifty per cent have been accepted. This campaign is still under way, and I can assure you a tabulation of the resulting savings in material and labor and in the use of machine tools is very impressive.

NOT so many months ago the outlook for alloy steel was not encouraging. You could almost lay on the chart the time at which our supply of critical alloys would be exhausted. By the most intensive campaign of conservation, aided very greatly by metallurgists and scientists from private industry, we have found ways and means to use leaner alloys to accomplish the same purposes that in normal peacetime employed high-alloy compositions. The Ordnance Department, which uses a large percentage of the alloy steel, has been most outstanding in its accomplishments. The net result of this intensive campaign is that today we can say that we are solvent as far as alloys are concerned. In other words, we are not faced, at our present production capacity, with an absolute shortage of alloys.

Tremendous savings of copper and brass have been made through substitutions. The largest individual item is the shifting from brass to steel for cartridge cases. This was an extremely difficult undertaking, but the program is making headway and certain sizes of artillery ammunition are being produced in substantial quantities. It is expected before many months that practically all our artillery ammunition will have steel cartridge cases.

As a few instances of conservation, a change in one item of a combat airplane saved sufficient aluminum to build 500 planes. Again, there are various changes in artillery products that have saved thousands of tons of steel. When the lumber situation reached the critical stage, we brought to Washington a group of technologists recruited from industry and submitted to them some 500 Army specifications for them to review in the light of material shortages. The suggestions of the group for modification and for permitting the use of alternate types of wood have already relieved certain points of critical shortage.

We are undertaking in every possible way to reduce the number of sizes and types of different items. As an instance, through conferences with the various Army services we found it possible to reduce small engine-driven generator sets from 63 to 14 models and also to reduce the number of types of air-cooled engines from 94 to 46. We are constantly reviewing and revising the designs of packing and crating. By this redesigning, we are not only creating better products, but we are saving invaluable shipping space. We have recently formed an Army and Navy standards group which will undertake to adopt uniform specifications between the two services on items that differ but little.

An entirely new kind of conservation recently came into being with the establishment of the Foreign Industrialist Information Section. Into this section we have gathered close to one hundred expatriated industrialists and outstanding experts in foreign industry, all of whom are now resident in the United States. These men are bringing to us the knowledge they have gained through a lifetime spent in building up the German industrial machine. Some remarkable results have already been accomplished by making available this knowledge of what our enemies are doing. This group is now being supplemented by quite a large number of American citizens who spent many years as residents in foreign countries. In other words, the Army organization is undertaking to bring together every particle of technical or strategic knowledge available in this or foreign countries.

The Ordnance Department, realizing the need for the closest coöperation with American industry in its vast task of arming our allies and ourselves, formed Industry Integrating Committees. As General Campbell, Chief of Ordnance, so aptly phrased it, "To integrate industry is to increase and balance production, avoid mistakes, make skill available to all, reduce costs." Through these committees desired production is obtained with a minimum of facility requirement. The skill and knowledge of the large manufacturer are made available to the newcomer or the small manufacturer, bringing him into full production in the shortest possible time. There is made available to the Ordnance Department on short notice complete information as to the productive capacity of the industry, its inventory of parts and material, and scheduling at source is made possible to meet the requirements of the using services.

In ten of the thirteen Ordnance districts, the Chief of Ordnance has organized machine-tool panels to provide technical assistance on production-equipment problems. These panels, made up of outstanding men in the machine-tool industry, operate to accelerate the time in which contractors will begin actual production, reduce to the minimum the quantities of new machine tools on order or to be ordered, and utilize the maximum of subcontracting.

THE production management of the war machine is fundamentally the same problem that faces any individual industry. The difference is in the magnitude, which makes necessary the use of what appear to be unwieldy organizations to accomplish the result that in any moderate-sized business is accomplished by executive management. We try to plan it so as not to run short of the basic elements of production, and when we do run short, which inevitably does happen at times, we use every resource known to man to remedy the deficiency.

I have been told that in the Army as a whole, twenty-four out of twenty-five officers are recruited from civil life. In the Ordnance Department, General Campbell states that 97½ per cent of his personnel were civilians 2½ years ago. In other words, the Army's war program is being carried forward by the same individuals and with the same knowledge that was previously used in private industry.

I can also say from intimate association with Army officers that the Army has no desire—as some irresponsible critics assert—to direct the civilian economy. The Army's industrial war plans have always called for civilian agencies to mobilize the national resources for the support of a war. The War Production Board and collateral civilian agencies, such as the Petroleum Administration, Defense Transportation, and Price Control, are charged with such duties and are ably performing their difficult tasks. The War Department desires merely to continue in its special field in which it alone is competent, not only because of the experienced men in its service but also because through the years Army officers and American industry have worked together in prewar planning and are now fighting side by side to defeat our enemies. We must see to it that our team is not broken up; for our team is invincible.

American Artillery

ONE of the brighter spots of the present war has been the performance of American artillery in battle. Whether in airplanes, tanks, or on the ground, our cannon time and again have blasted the enemy with superior firepower. Our aircraft are armed with 20- and 37-mm. guns; our medium tanks mount 75-mm. and 3-inch guns, and our tank destroyers carry 75-mm. guns and 105-mm. howitzers; the Infantry uses 60- and 81-mm. mortars and the 37-mm. antitank gun; antiaircraft forces are armed with 37-, 40-, and 90-mm. weapons.

However, for devastating concentrations of high explosive that flatten the enemy's wire, crush his pillboxes, engulf his trenches, destroy his personnel, and silence his big guns, the weapons of the Field Artillery are supreme in accuracy, sustained fire, and flexibility. They include the 75-mm. gun and howitzer, the 105-mm. howitzer, the 4.5-inch gun, the 155-mm. gun and howitzer, and the 240-mm. howitzer. As is commonly known, howitzers have shorter barrels than guns of the same caliber, have a high angle of elevation and a steeply curved trajectory so that they may fire while concealed from the enemy behind the crest of a hill or other barrier. Using indirect fire, they can drop their projectiles on hostile targets similarly concealed. Guns, having a flatter trajectory, are used for direct fire upon enemy targets or against those out of range of the howitzer.

The 75-mm. gun was the standard light artillery piece used by United States troops in World War I. It has largely been superseded in this rôle by the new 105-mm. howitzer which combines characteristics of both gun and howitzer and has greater range, flexibility, and effectiveness. The 75-mm. gun is now largely used as an antitank weapon. The 75-mm. howitzer is an excellent infantry-accompanying weapon and may be towed at high speed on its pneumatic-tired carriage, carried in several loads on pack animals, landed from airplane, or dropped by parachute.

The Army's new 4.5-inch gun on its high-speed carriage is suitable for corps artillery or antitank missions. Its companion piece, the new 155-mm. howitzer mounted on the same carriage, will replace the World War 155-mm. Schneider-type howitzer, long standard in the Army.

The new 155-mm. gun on mobile carriage is the long-range, heavy-hitting gun of the Army. Mounted on pneumatic tires, it may be moved speedily over good roads and can travel anywhere a truck can go.

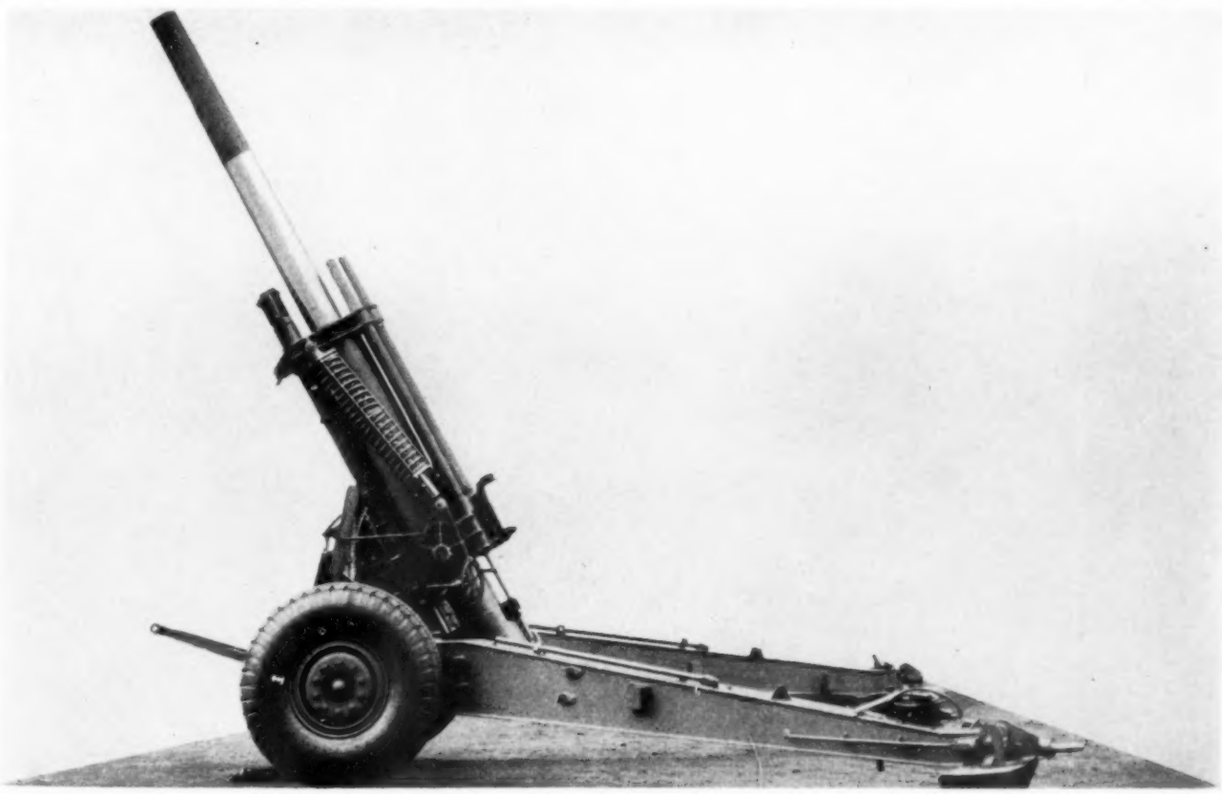
Such fast-moving artillery is doing excellent work in today's fluid combat. But once the enemy is driven within the strongly fortified "fortress of Europe," or elsewhere, the fighting may revert to siege warfare. If so, the Army is ready to blast the enemy from his strongholds with such guns as the new 240-mm. howitzer. Despite its great weight, this weapon is also mobile, the barrel and carriage each being towed by a 10-ton prime mover. These are the guns that stand ready to speak out against the enemies of America. (Most of the accompanying illustrations are from Signal Corps photos unless otherwise indicated.)

Light Field Howitzers

The 75-mm. howitzer on high-speed carriage, shown above guarding an important crossroads, is an excellent infantry-accompanying weapon. It may be carried by pack animals or airplane or towed behind a ground vehicle. The 105-mm. howitzer, below, is now the Army's standard light artillery weapon. It has proved very effective against enemy armor.

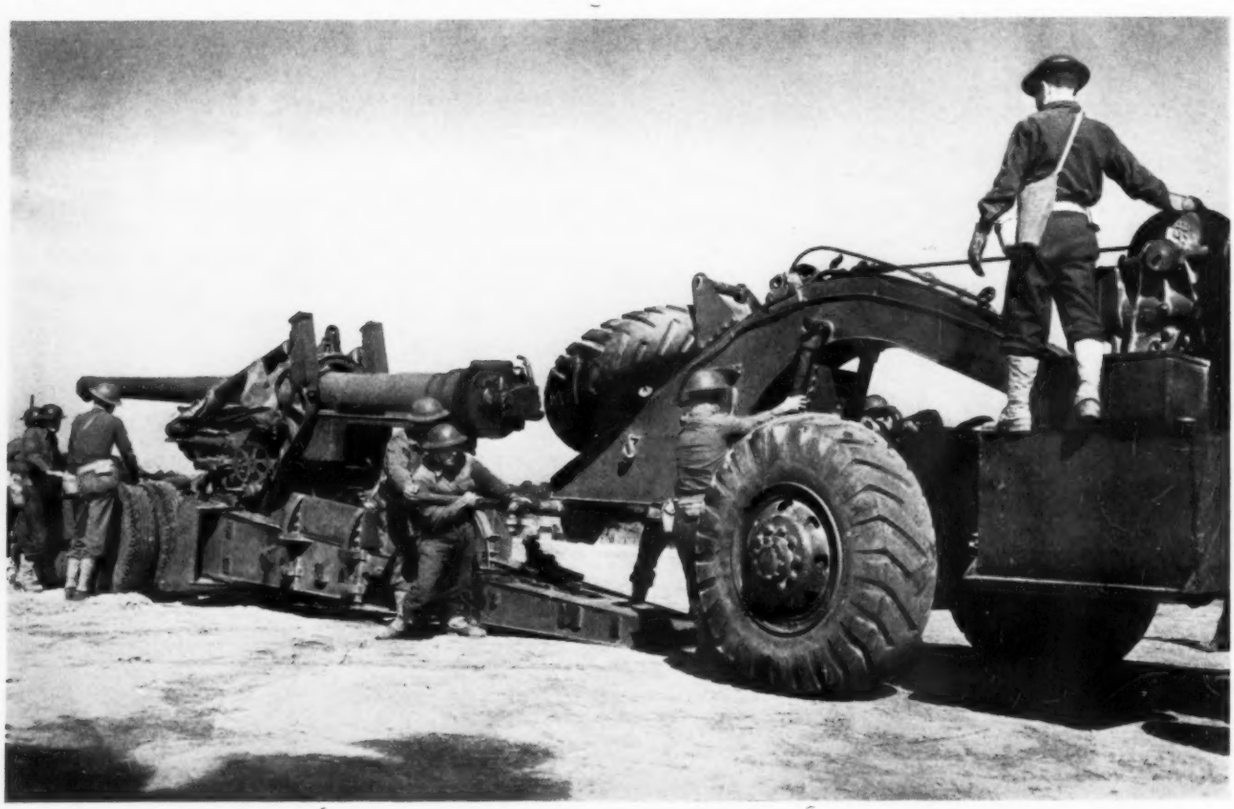
Light and Medium Field Guns

The 75-mm. gun, above, formerly the standard light artillery piece, is now being used as an effective antitank weapon; it has good range and a flat trajectory. The Army's new medium field gun, the 4.5-inch weapon shown below, is suitable for corps artillery or antitank missions. It is mounted on the same carriage as the new 155-mm. howitzer shown on page 518.



Fast-Moving Heavy Artillery

The Army's heavy field gun is the fast-moving, hard-hitting, long-range 155-mm. weapon shown above on its high-speed carriage behind its specially designed 7½-ton prime mover. The long barrel is moved rearward in transit to save road space and afford better balance. On reaching the firing point, the tractor is disconnected from the gun as shown below.



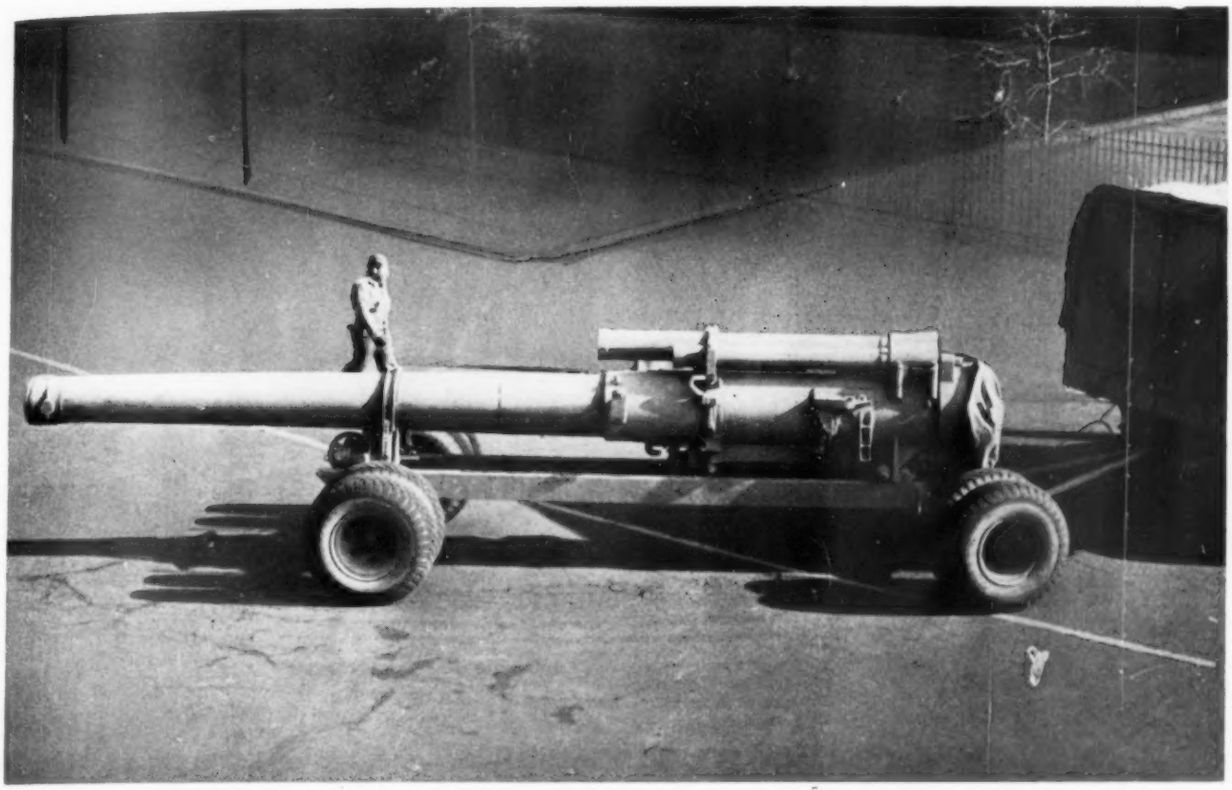
The 155-mm. Field Gun

The barrel is then moved to the in-battery position by a cable run from the prime mover's power winch through a pulley to the gun breech as shown above. Below, the barrel is shown in position and the crew are about to spread the split trails preparatory to firing. The new weapon can be emplaced much more quickly than the World War type 155-mm. gun.

The 155-mm. Howitzer—New and Old

The new 155-mm. howitzer, shown above in travel position on its pneumatic-tired, high-speed carriage, is classed as medium artillery. It has a high angle of elevation, giving its projectile a steeply curved trajectory. The new weapon will replace the Schneider-type 155-mm. howitzer shown below. Even this World War piece has been modernized for high-speed transport.

The 240-mm. Howitzer—New and Old



The Army's heaviest mobile field weapon is the new 240-mm. howitzer, the barrel of which is shown above being towed by a 10-ton prime mover (Acme photo). The carriage is towed by a similar vehicle. Despite its great weight, this piece can be moved at a good speed and emplaced in less time than the World War type 240-mm. howitzer shown below.

Guns for Air Defense

American antiaircraft artillery also has achieved remarkable results in this war. The mobile 90-mm. antiaircraft gun, like the one shown above, destroyed many Japanese planes over Corregidor, while a multiple-gun motor carriage, like that below, armed with twin cal. .50 machine guns and a 37-mm. cannon, knocked down nine planes near Algiers (Acme photo).

Key to Arms Production

The Ordnance Procurement Districts at Work—Part IV

THE Ordnance procurement district system, which has done so much to insure an ample and ever-increasing supply of fighting equipment for our far-flung armies in the present conflict, is an outgrowth of the organization used in World War I. This system, established early in 1918 under the direction of the late Brig. Gen. Guy E. Tripp to decentralize procurement, was the result of intensive study of the best methods for obtaining complete munitions production throughout the United States in a national emergency.

It was just twenty-one years ago, however, on May 18, 1922, that Maj. Gen. C. C. Williams, then Chief of Ordnance, created thirteen permanent Ordnance district offices in various parts of the country for the decentralized procurement of ordnance. These districts surveyed the industries in their respective areas and made and kept modernized plans for all-out industrial production in the event of a major war. The present conflict found the Ordnance procurement system ready for the emergency, and today's war production record of private manufacturers in supplying our armed forces speaks for itself. The district system's part in contributing toward victory in World War II cannot be challenged.

This is the fourth article of a series published in ARMY ORDNANCE on the Ordnance districts. The first appeared in the May-June 1942 issue (Vol. XXII, No. 132, p. 945) and discussed the Cleveland, New York, Philadelphia, and Rochester Districts. The second article was published in the July-August issue (Vol. XXIII, No. 133, p. 59) and treated the Cincinnati, Pittsburgh, Boston, and Springfield Districts. The third article of the series, in the November-December issue (Vol. XXIII, No. 135, p. 497), outlined the achievements of the St. Louis and San Francisco Districts and the Los Angeles Ordnance Region. The present and final article discusses the Detroit, Chicago, and Birmingham Districts.

Detroit Ordnance District

Brig. Gen. A. B. Quinton, Jr.

THE story of the Detroit Ordnance District is, in a large part, the story of the conversion of the automobile industry to war. This great mass-production industry is centered in the Lower Peninsula of Michigan, the territory assigned to the Detroit Ordnance District. Largest of the nation's manufacturing industries, the automobile builders and their associates carried a heavy burden in World War I and are shouldering an increasingly greater share in World War II.

Revived in 1922, the Detroit Ordnance District, like other districts, operated on a skeleton basis, planning and surveying, until the war clouds gathered over Europe. Quarters in the Federal Building at Detroit were outgrown, and, in February 1940, offices were occupied in the First National Bank Building. Since that time, additional space has been required until, in November 1942, the district was quartered in 225,000 square feet in the bank building and 55,000 square feet in two other downtown Detroit structures.

When the writer was assigned to the district in 1934 as executive assistant, he found a small office, a secretary, and a minute budget which provided five dollars a year for long-distance telephone calls and twenty-five cents a year for telegrams! When he returned as deputy district chief in June 1942, he found an organization of some seven thousand persons scattered over three Detroit office buildings, four suboffices, and hundreds of facilities, large and small. From 1934 to 1938, the writer worked with the late Alex Dow, who accepted appointment as district chief in 1932. Plant surveys, careful planning, and long consultations with industrial leaders laid the foundation for the sudden expansion to come.

ON December 1, 1942, the Detroit Ordnance District had contracts under administration totaling more than five billion dollars. Vouchers submitted for payment during the single month of November amounted to more than $145,000,000. There were nearly 3,000 prime contracts being inspected and almost 5,000 subinspection requisitions. Assigned to the district on December 1st were more than 100 officers and over 8,127 civilians. During October, there were more than 12,000 shipments of war matériel from the Detroit Ordnance District, over 9,000 of which were full carloads.

The district operated with but a small staff until late in 1940 when a slow increase in personnel began. Late in 1941, the employment shot rapidly upward with about 900 a month being added. This continued through June 1942 when the rate of increase began to drop. A decrease in personnel was noted in September over August, but the absorption of over 600 Motor Transport Service employees in October offset the more than 500 separations and sent employment to an all-time high. In November, the payroll total dropped by several hundred.

The death of Mr. Dow in March 1942 brought to an end a decade of valuable service to the Ordnance Department. Col. R. Z. Crane ended his 4-year tour of duty as deputy district chief in June 1942, and the writer returned to the post he had occupied from 1934 to 1938. A month later he was named district chief.

Outstanding businessmen in the Detroit area have been brought into the organization. Oscar Webber, for twenty years vice-president and general manager of Detroit's largest department store, was named deputy chief in August 1942. Three business leaders, William G. Lerchen, James B. Angell, and John H. French, accepted appointments to the Price Adjustment Board in the fall of 1942. The district chief has the aid of four special assistants, all on active duty with the district, and an advisory board of five. All were selected from private life and brought to the district records of exceptional experience and achievement.

On January 1, 1942, the Detroit Tank Arsenal became a part of the Detroit Ordnance District. Operated independently since its establishment, the arsenal was absorbed by the district in accordance with the policy of the War Department to centralize administration, inspection, and procurement of matériel within the districts.

While an estimated eighty-five per cent of the five billion dollars' worth of contracts administered by the district is held in the southeastern section of the Lower Peninsula of Michigan within a 65-mile radius of Detroit, many facilities are scattered throughout the state and are administered through suboffices located in Lansing, Saginaw, Grand Rapids, and at the Great Lakes Steel Company in Ecorse. Peculiar to the Detroit Ordnance District is its international aspect. Through a suboffice in Ottawa and branches in Montreal and Toronto, the district administers contracts with War Supplies Limited, a Canadian governmental agency which contracts with the United States for the delivery of matériel.

With the vast facilities of the automotive industry centered in Michigan, there is great variety in the items manufactured in the Detroit Ordnance District. Most spectacular, perhaps, are the tanks built by the three large motorcar manufacturers. Combat vehicles, armored cars, and other motorized equipment roll from the assembly lines of the auto plants while others build guns ranging from caliber .30 to 4.7 inches. Shells of a wide variety come from other plants of the industry along with hundreds of other items for which their machinery and equipment have been converted.

But the Detroit District's connections are not solely with the automotive industry. A former printing-press manufacturer builds gun mounts and carriages; a vacuum-cleaner company works on ammunition; a camera builder makes telescopes; a gasoline-pump company is engaged in manufacturing belt fillers and artillery parts; a refrigerator firm has contracts for bombs; a water-heater company builds bomb tail fuzes; a one-time golf-club manufacturer works on belt links and shell; and many other firms are producing for war. The many machine-tool companies in the Detroit area have made valuable contributions to the war effort and have expanded their facilities to accommodate the rocketing demands for their highly specialized products.

The contracts, first of which were signed in May 1940, cover projects ranging from medium tanks to tiny fuze parts. In value, the contracts vary from more than half a billion dollars down to less than a thousand dollars.

When the widespread facilities of the automotive industry and the genius of its executives and engineers are considered, it is easy to accept the recent statement of the president of one of the larger companies: "In Detroit we can build anything we can sell. If the Government wants it, we'll build it."

Chicago Ordnance District

Brig. Gen. Thomas S. Hammond

THE Chicago Ordnance District comprises an area of approximately 406,000 square miles within which is situated an amazing variety of industrial enterprises. Specifically, the district includes the states of Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, the northern half of Illinois and Indiana, and the Upper Peninsula of Michigan. Consistent with the decentralization policy of the Ordnance Department, the district maintains its headquarters in Chicago and has suboffices in Rockford and Peoria, Ill.; Minneapolis, Minn.; Davenport, Iowa; Milwaukee, Wis.; and Fort Wayne and Calumet City, Ind.

The start of the Chicago District dates back to the establishment of the Ordnance district system slightly over twenty years ago. Long before Pearl Harbor, many military and industrial leaders were becoming increasingly aware of the strategic importance of this inland industrial area with its unsurpassed transportation systems on land, on water, and, in recent years, in the air; its proximity to the rich ore deposits of the Lake Superior region, and its tremendous steel mills.

Despite an awareness by some that this section of the country was destined to play a leading rôle industrially if and when the nation should become engaged in war, the Chicago District, like the other Ordnance districts, was forced to function for many years with a nucleus organization and limited funds for educational contracts. It, too, had to withstand many attacks by the public and by certain sections of the press which, during many peacetime years, were opposed to the Ordnance set-up in practice and theory.

FORTUNATELY for the nation, the maintenance of even this nucleus organization provided the spark which lit the fires of ordnance production in 1939 when the War Department turned to private industry with orders for matériel marked "urgent." At that critical time, the men in the War Department who were charged with the responsibility of getting the huge Ordnance program under way placed a large share of the industrial load with the Chicago District for a variety of reasons. Most important of these was the fact that a large number of industrial leaders in the Middle West were ready and willing to bring their plants into ordnance production even though in many instances it meant going through conversions of the most radical type. Coupled with this spirit of coöperation on the part of manufacturers in all sections of the district were a number of other important factors.

Besides an adequate labor market, a vast network of railway lines, trucking lines, and water-transport facilities, and a huge steel industry, the Chicago District had within its boundaries two of the foremost machine-tool manufacturing centers in the nation—Rockford, Ill., and Milwaukee, Wis. Those charged with the procurement of artillery found at their disposal large road-machinery plants equipped with big lathes and large mills ideally suited to this type of production. With the aid of the Rock Island Arsenal, which for twenty years had kept up experimental work on gun barrels and gun carriages, the district was soon occupying a leading position in the manufacture of this type of equipment—a position it still maintains.

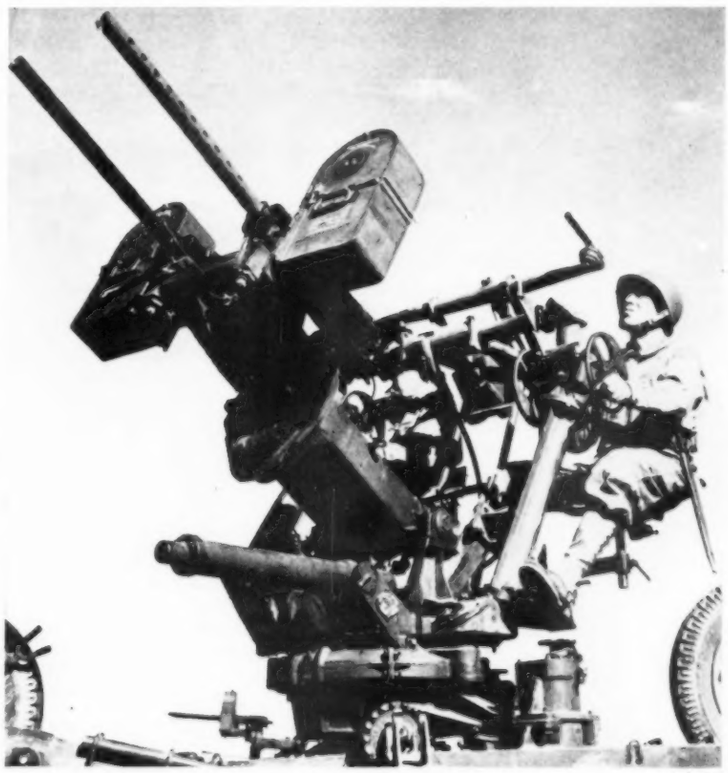
Confronted with the problem of getting a heretofore nonexistent tank program under way as rapidly as possible, the tank-procurement branch of the Ordnance Department, aided by Lend-Lease requirements, found available within the Chicago District the nation's leading car builders who, due to the vicissitudes of the economic system, had huge plants which were not operating to full capacity. The story of how these plants were converted into efficient tank arsenals now turning out the finest tanks to make their appearance in this war, is a saga of American industry. Even more phenomenal has been the manner in which these tank manufacturers of the district have brought hundreds of small subcontractors into the production picture.

A further aid to the war effort was the existence within the Chicago District of the nation's leading tractor factories which were quickly adapted to the manufacture of various types of tractors and prime movers. Prominent truck-manufacturing concerns were also found ready and waiting to produce half-track personnel carriers and other types of combat vehicles.

Ammunition was another phase of ordnance production that was able to utilize quickly the industrial resources of the Chicago District. The conversions in this field proved the most extreme and the most dramatic. The producers of washing machines, ironers, and stoves centered around the Middle West fitted into the ammunition picture. Makers of cooking utensils, watches, "juke boxes," agricultural equipment, and fountain pens likewise joined the parade toward complete industrial mobilization. From the standpoint of number of facilities involved, volume and variety of output, and engineering contributions, the ammunition branch of the Chicago Ordnance District ranks extremely high.

The small-arms branch had placed at its disposal brass plants and a variety of manufacturing concerns in such industrial centers as Chicago, Milwaukee, Minneapolis, Peoria, Moline, Rock Island, and Davenport. As a result, it has made important strides in the manufacture of links, bullet cores, brass cups, ammunition boxes and chests, machine-gun mounts, and carbines.

Today, after more than a year of war, the results achieved by industry within the Chicago District more than contradict the early whisperings that the great Midwest was apathetic toward the urgency of this country's war requirements. During 1942, the district's disbursements showed a gradual increase from $20,279,640 in January to $132,126,378 in December. At the close of the year the district was dealing with 608 prime contractors and over 18,000 subcontractors and was administering 4,073 prime contracts with a total valuation of $3,534,957,145.



Acme

AN ANTIAIRCRAFT WEAPON PROCURED THROUGH THE ORDNANCE DISTRICT SYSTEM

Two caliber .50 machine guns are mounted coaxially on a mobile carriage similar to that used for the 37-mm. antiaircraft gun. The guns may be aimed manually or in conjunction with a direction finder in defense against low-flying planes.

THE phenomenal growth of production within the Chicago Ordnance District during the first full year of war has also seen a furthering of the teamwork and coöperation between this Army procurement agency and private industry. For example, all officers in charge of district suboffices and the district chief himself are receiving valuable aid and assistance from able advisory boards composed of men who are outstanding industrial leaders.

Further emphasis has been and is being placed upon perfecting the district's operating methods and techniques which the urgency of war made it necessary to develop speedily. The district is proud of the fact that its total expenditures for procurement expediting, production engineering follow-up, inspection, and payment are only one per cent of its current total disbursements. Many of these developments, both large and small, have been found adaptable to the Ordnance picture as a whole. Among these developments is the plan initiated by the fiscal branch for securing financial data on bidders before awarding contracts and the preparation of an advance-payment manual which has had wide distribution, many of the procedures having been adopted by other districts in various parts of the country.

Manufacturing facilities dealing with this district have available to them written packaging and loading specifications complete with photographs. Many of the packing techniques developed by the district have been adopted as standard by the Ordnance Department and by the Association of American Railroads.

The district's planning division has made many contributions toward utilizing local industrial resources as efficiently as possible. It has, for example, made a careful investigation of the need for machine tools in ordnance plants, and, as a result, orders for 429 tools costing $2,500,000 have been canceled because they were in excess of actual requirements. In addition, 609 tools costing $3,334,000 have been transferred to other plants where the need for them was greater. This division also has greatly relieved the bottleneck in the local perishable-tool supply by bringing over 150 companies into production on these critical items. Through an ingenious card system, the planning division now keeps an up-to-the-minute record of the idle capacity on critical machine tools as reported by over 1,600 companies. All this has made it possible to bring over 300 small subcontractors into the Ordnance picture during recent months.

By way of tribute to both management and labor within the Chicago District it should be recorded that during 1942 the proportion of man-days lost due to strikes in plants of the district's prime and subcontractors was appreciably below the proportion of man-days lost nationally. This fine labor record has made it possible for hundreds of war plants to function efficiently and to produce ordnance matériel at unprecedented rates.

Under the leadership of Brig. Gen. Thomas S. Hammond, I.N.G., Ret., who has been district chief since September

1942, the Chicago Ordnance District will strive during the days ahead to perfect its function as a procurement agency and service unit for industry. For, confronted by ever-changing production requirements, by material shortages, and by increasingly serious man-power problems, private industry in the Middle West faces just as enormous a task in the future as it has experienced in the past.

Birmingham Ordnance District

Capt. Roy D. Hickman

COMING into existence in 1923, a year later than the other district offices, the Birmingham Ordnance District occupies a position unique in its strategic location. Encompassing the five states of Alabama, Georgia, Florida, Louisiana, and Mississippi, each of which borders at some point either the Atlantic Ocean or the Gulf of Mexico, transportation facilities, both water and rail, are unexcelled. Of even greater importance is the fact that Birmingham, of all the world's steel-producing centers, has at hand, within an 8-mile radius, all the raw materials incorporated in this vital war commodity. From Red Mountain come ore and limestone, and from the seams and fields to the west comes coal. Down in the valleys, blast furnaces reduce the ore and pour it into steel ingots, and Birmingham's mills and forges turn it into finished products. Thus, the percentage of semifinished products emanating from the Birmingham District is greatly reduced, and the district is largely self-contained.

At the present time, the district is charged with the responsibility of administering and inspecting some 157 prime contracts and 133 subcontracts, with a total value of approximately $140,000,000. Included in these contracts are more than $8,000,000 worth of Government-owned machine tools and 7,000 Government-owned gages. While the availability of one of the most essential materials of modern warfare has made it possible for many manufacturers in this district to specialize and concentrate their efforts in the production of single items, other plants have diversified their activities, and approximately seventy-five different ordnance items are rolling off production lines in this area with speed and efficiency.

The Birmingham Ordnance District has been active along many lines, none of which is more pronounced or outstanding than its assistance to the small plants and industries in this area. A special effort has been made to see that small manufacturers are referred to the proper sources and put into the proper channels necessary to secure contracts for ordnance matériel. Many of these firms, but for the guidance of the Birmingham Ordnance District office, would not have been able to meet the required Government regulations. With the exception of less than five concerns, all contracts placed in this district are with small manufacturers, and it is with particular pride that we point to the fact that already a number of these have been awarded the Army-Navy "E" for high achievement in war-matériel production.

Not always has this district been the nucleus of southern industry that it is today. With the districts, as with other Ordnance establishments, peacetime is mostly an era of plans and preparation, and it is only when a national emergency becomes acute that their wealth of available information on manufacturing processes and equipment and their uses for ordnance fabrication enables the districts to reach an unprecedented peak of production.

The majority of plans under which the Birmingham Ordnance District operates today are the result of the far-sighted outlines made by officers in charge from the beginning. Shortly after World War I, the first district officer conducted surveys and began compiling valuable data on the resources, plants, and facilities of the district. The great potentialities of this area were noticed by these early surveys, and a record was made of the number of machine tools existing and an estimate compiled of the items that could be manufactured in the event of war. Records show that one firm agreed as far back as 1932 to manufacture 150,000 hand grenades a month. This same firm today—10 years later—is producing more than 200,000 grenades a month—far in excess of what it thought could possibly be done.

THE first educational orders came to the district in late 1939 and were completed in late 1940 and early 1941, and, as the national emergency became intensified, firm after firm began converting its installed equipment to meet wartime requirements. One firm converted from the manufacture of cotton ties and springs for wagons to the manufacture of shells. Another which had made trailers for years is now turning out bombs. Thus, the Birmingham Ordnance District began to come into its own, and contracts today range from a few thousand dollars up to several million dollars in value.

As late as 1940, the personnel of the district consisted of six commissioned officers and sixteen civilian employees, but the ever-increasing expansion in production made it necessary to double the number of office personnel many times. This number fluctuated widely during the formative stages of organization until it reached its peak several months ago, and at present it has been reduced to a streamlined organization of 40 officers and 655 civilian employees. To insure the greatest efficiency and to facilitate the war effort, the district office operates under six divisions: executive, legal, safety and security, general-office, industrial, and suboffice-administration. Under these divisions, thirty-five separate sections have a particular job to do, working under the direction of chiefs well versed in Ordnance technique.

Up until last September the details of all contracts were handled and cleared through the Birmingham office, but because of the continuing expansion of Ordnance activities and in order to insure faster processing, fewer delays, and increased efficiency, speed, and coördination, suboffices were established in Atlanta and New Orleans, and advisory board panels of outstanding business men fully acquainted with the particular problems and potentialities of their respective areas were set up in the two cities to act in an advisory capacity to the suboffices. This district is very proud right now of the results that are being obtained by our conversion engineering section—the principal function of which is to encourage suggestions from industries and workers on ways and means to conserve strategic materials.

True, we are the "baby" of the Ordnance Department; our dollar value of contracts is considerably less than that of other districts, some firms in other districts having single contracts amounting to more than our entire allotment. However, we feel that with the coöperative spirit prevailing among the personnel of our district, and under the leadership of Col. Ernest C. Bomar, our district chief, and Herbert Tutwiler, our deputy district chief, our manufacturers, small though they be, will continue to forge to the front and that the Birmingham Ordnance District will give a good account of itself when victory is won and results are tabulated.

Ordnance Personnel Procurement

The Problem of Obtaining Skilled Officers and Men

Capt. Bernard B. Abrams

IN order to begin a discussion of the Ordnance organization of the future, it becomes necessary first to look at Ordnance in retrospect. In 1917, the Ordnance Department consisted of 97 officers and 1,241 enlisted men—a few months before the United States entered the first World War. After the declaration of war, the Department was rapidly expanded into a force numbering 4,527 officers and 25,054 enlisted men. This expansion took place over a period of a few months, and the personnel consisted, for the most part, of men brought in from civilian life with no previous ordnance training, experience, or interests. There was no reservoir of trained technicians prepared to step in and do the job.

The declaration of an emergency by the President of the United States in 1940 found us infinitely better prepared than in 1917, but the Ordnance Department was still a small and efficient organization composed of about 350 commissioned officers and 4,500 enlisted men. This group was supplemented with about 800 Ordnance Reserve officers, most of whom were on active duty within a few months after the attack on Pearl Harbor. Again there was no large reserve of trained Ordnance men.

At the present time, about 10,000 commissioned Ordnance officers are serving on active duty, with a proportionate number of enlisted men. There were more men undergoing training in the various Ordnance training installations last year than there were men in the entire United States Army in 1939.

Where did these men come from? First of all, officers and men from branches of the service other than Ordnance who possessed the required technical qualifications, were transferred, detailed, or assigned to Ordnance. Many of these came from the Coast Artillery, Field Artillery, Quartermaster Motor Transport Service, and mechanized Cavalry units. These branches of the service performed work closely allied to that of the Ordnance Department. The transfer was made from the three peacetime components of the Army—Regular Army, National Guard, and Organized Reserves. Current R.O.T.C. graduates of the country's colleges and universities who had completed engineering and scientific courses were in some cases commissioned and called to duty in the Ordnance Department, regardless of the branch of the R.O.T.C. in which they had been enrolled as students. This situation will be discussed in detail later.

Another means of procuring skilled officers and enlisted men, particularly the latter group, was through the plan of affiliation. Under this method, Ordnance regiments, battalions, and companies were recruited from large business and industrial concerns. Some units were comprised entirely of men from the automotive industry. Except for the commanding officer, the personnel were brought in from civilian life. However, a substantial number of those tendered commissions had served in the last war. In this connection, the National Automobile Dealers Association was especially helpful in recruiting qualified men. The policy of affiliation has been brought to an end, but affiliated units may be found in service in many parts of the world. The practice of issuing commissions to applicants from civilian life has also been brought to a halt due to the fact that the Ordnance Officer Candidate School is now turning out more than 200 second lieutenants each week. A very few commissions may still be issued to specialists listed in scarce categories, such as electronic physicists, metallurgists, and graduate engineers.

IN time of war, Ordnance requires the services of men representing just about every trade and profession. It has been said that every product made by man goes into the building of a battleship and that men from every trade are utilized in its construction. If this is so, then ordnance is like a battleship, as those same characteristics are true. The big problem encountered by the Ordnance Department in wartime is procuring these skilled persons immediately and fitting them into the right positions.

It appears as though Ordnance is really little known. Even brother officers of the Army have been known to ask Ordnance officers the significance of the shell and flame insignia on their collars. It is a popular misconception that the work of the Ordnance Department is confined to the manufacture of guns and ammunition. The multitude of other missions is usually overlooked, such as the training of Department personnel; storage, issuance, and repair of all ordnance matériel; research programs; the development of materials; the procurement, inspection, and acceptance of ordnance matériel; and the construction of new manufacturing plants.

Several cases may be pointed out where a little "missionary work" has given others a clear understanding of the Ordnance Department, resulting in benefits out of all proportion to the effort expended. One example is that of an Ordnance officer on duty in an eastern Ordnance district who became interested in a small engineering college near by. This college did not have an R.O.T.C. unit, so the officer endeavored to acquaint interested students with the Army by delivering addresses before meetings of student societies, by conducting tours through Ordnance establishments in the district, and, most of all, by selling himself to the faculty and students of the school, thereby selling Ordnance to them. All this took place during the years immediately preceding the present war. In those days it was possible for graduates of engineering schools to qualify for reserve commissions in technical branches of the Officers' Reserve Corps by enrolling in Army extension courses and passing an examination conducted by a board of officers. In this manner, many of the graduates of the college referred to obtained Reserve commissions. All these officers are now on active duty and are rendering valuable service to the war effort. This took place at one school. Imagine the large corps of technically trained officers that could have been

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developed if each district Ordnance officer would have thus "adopted" an engineering school during the years of peace!

As a second example, a few weeks prior to June 1942, arrangements were made with The Adjutant General's Office whereby most of the 1942 R.O.T.C. graduates who had completed academic courses in mechanical engineering were to be assigned to duty in Ordnance, regardless of the branch in which they were enrolled as R.O.T.C. cadets. It was also agreed that 1942 Ordnance R.O.T.C. graduates who had completed courses in civil engineering would be released for assignment to the Corps of Engineers; electrical engineers to the Signal Corps, etc.

WHEN these young officers reported for duty with the Ordnance Officers Replacement Pool at Aberdeen Proving Ground, Md., they were, frankly, a disgruntled group. Some had already served a few weeks of active duty with branches of the service for which they had been trained. Those in the Corps of Engineers had been taught that theirs was the elite branch of the Army. Cavalrymen from Fort Riley were positive that their branch was the best. None of them knew what to expect in Ordnance other than that they might become plant inspectors or gun testers. To counteract their downcast feeling, each one was given an opportunity to discuss his case with a staff officer of the Ordnance Training Center. During these interviews they were given the true picture of Ordnance. Foremost in the minds of all was a desire to perform some type of work in the Army which would keep them professionally qualified in mechanical engineering, the field for which they had prepared in college and hoped to enter as civilians after the war. It was not difficult to show them that Ordnance duties involved mechanical engineering and would give them experience which would be valuable in civilian life.

It was further explained to the above group that their academic college course in mechanical engineering actually qualified them for Ordnance in many respects more than did their R.O.T.C. course for a particular branch of the service. This point was sustained by the fact that almost full time in classroom instruction and preparation was devoted to academic subjects while, on the other hand, only about three hours a week were given to R.O.T.C. training. Of the three hours a week, a substantial portion was spent on general military subjects common to all branches, such as close- and extended-order drills, sanitation and first aid, marksmanship, weapons, military law and history, administration, etc. The amount of time occupied with specialized training was considerably less. It may be seen, therefore, that the R.O.T.C. program gave the students a military background and instilled in them the qualities of leadership, but, from a standpoint of hours of instruction, the academic course was more of a qualification for assignment, as far as Ordnance was concerned, than was the specialized military instruction.

In a further attempt to assign these R.O.T.C. graduates to positions with which they would be content and also to illustrate the diversified part played by Ordnance, assignments were made as follows: Those who originally had been in the Cavalry were assigned to medium-maintenance companies attached to Cavalry divisions or to the maintenance battalions of armored divisions. Artillerymen were placed on duty in the artillery sections of heavy-maintenance companies. Antiaircraft Coast Artillerymen were detailed to the fire-control sections of the antiaircraft brigades. Infantrymen went to the small-arms sections of light-maintenance companies. Business-administration graduates were sent to depot companies and to Ordnance depots. Many chemical engineers and metallurgists were assigned to industrial plants. Unanimously, these R.O.T.C. graduates were satisfied.

From a personnel standpoint, it may be seen that engineering schools, whether they have units of the R.O.T.C. or not, are one of the best sources of development in the building of a trained Ordnance Reserve. The question of bringing Ordnance to the attention of engineering students was first discussed in 1942 with the Civilian Advisory Council to the Military Training Division, Office of the Chief of Ordnance. This council includes in its membership the presidents and deans of some of the nation's outstanding colleges and the executives of some of the leading industrial concerns. It was the unanimous opinion of this group that the problem would not be solved by adding Ordnance subjects to college curriculums. Such a step would not bring the whole story of Ordnance to the student; moreover, the curriculum at most schools was already overcrowded.

THE following course was finally decided upon: First of all, selected Ordnance officers would be sent to the various schools to address student groups and tell them the story of Ordnance. It was proposed to supplement these talks with literature and pictorials. Small Ordnance units were then to be organized and sent on a tour of the schools to demonstrate their equipment and how they operated in the field. It was suggested that sound films be made of all Ordnance activities to be used in lieu of Ordnance field units should the latter not be available for demonstration purposes. Throughout all this program it was stressed that high-pressure salesmanship was not to be used. There was to be no recruiting and no "signing up." This was to have been a long-range program, and it was hoped that by presenting Ordnance in the proper manner the students would affiliate themselves with the Department at some later date. It was planned also to employ this same program with technical groups other than student bodies.

The program, as outlined above, was drawn up and presented to the Joint Army and Navy Committee on Recruiting for its approval. But at this point the plan unfortunately came to an end because of a ruling that had just gone into effect prohibiting individual branches of the services from going into the schools for recruiting purposes. Under the new ruling, only joint groups representing all branches of the services were permitted to visit the schools.

At a meeting of the Civilian Advisory Council held in Detroit, Mich., in November 1942, the problem was again discussed and a substitute plan devised. Instead of going into the colleges it was decided to bring representatives of the schools to the Ordnance Department. Under this program, the presidents and deans of the country's engineering schools were invited to visit the Ordnance Training Center and the Ordnance Proving Center at Aberdeen Proving Ground to see ordnance in action. The visit took place early in January 1943 and lasted three days. Representatives were present from all parts of the country. They were shown enough to go back to their schools and "sell" their students on Ordnance in the event that they themselves were sold. Letters received from the delegates at a later date indicated that they were enthusiastically in favor of the Ordnance cause, thus solving a vital factor in the personnel problem.

Decius Wadsworth

First Chief of Ordnance, U. S. Army, 1812-1821

By Col. C. Wingate Reed

DECIUS WADSWORTH, first Chief of Ordnance in the United States Army, came from staunch New England stock. His grandfather, Capt. William Wadsworth, a distinguished veteran of the Indian and Colonial Wars, was of the fourth generation of Wadsworths in Connecticut. His mother, Mercy Clark Wadsworth, was the daughter of John and Elizabeth Newell Clark of Kensington and the great-granddaughter of John Clark,[1] one of the early settlers of Hartford County. The old Clark homestead now is incorporated in the city of New Britain.

William Wadsworth, father of Decius, lived in Farmington, Conn., in a house located approximately where the Catholic church now stands. He is described as a man of more than average attainment, of extraordinary intellect and self-assurance, but passionate and willful. All these traits were inherited to a marked degree by his son Decius and are evidenced throughout his entire career.

THE Ordnance Department was created as a separate branch of the Army by the congressional act of May 14, 1812—just 131 years ago—and the first man called to head the Department was Col. Decius Wadsworth whose biography is here so faithfully recorded by Colonel Reed. The trials and tribulations which beset the new organization in the midst of critical times in our nation's history are of particular interest to all students of Ordnance today when our country is again undergoing trial by fire.

The petty personalities that beset the young Army appear insignificant, indeed, in the light of a century and a quarter and remind us all to devote ourselves, above all else, to the immediate task in hand—that of winning final, absolute victory. Times and methods may change, but principles and human nature remain the same. In this portrayal of Decius Wadsworth, the first Chief of Ordnance, there is much inspiration from the struggles of the past and guidance for the future.—EDITOR.

Decius, first son of William and Mercy Clark Wadsworth, was born in his father's home in Farmington on January 2, 1768. Being of God-fearing parents, he was baptized the following day. In Farmington he spent his early youth, acquiring his primary education in the neighborhood grammar school.[2] Here the superiority of intellect that was to distinguish him in later years first was manifested, and he completed his preparatory studies well ahead of the neighborhood boys of his age.

In retrospect it seems but natural that Decius Wadsworth should turn to the military as a career. The descendant of a distinguished military ancestor, he had reached the impressionable age of eight on July 2, 1775, when General Washington assumed command of the conglomeration of Continental troops encircling Boston. The next eight years, perhaps the most formative of his life, were spent in an atmosphere of war.

At a very early age, probably about fourteen, Decius entered Yale College at New Haven. He graduated with honor in the class of 1785.

Having graduated, Decius considered the teaching profession as a career. In January 1786, young Wadsworth was the recipient of a flattering offer of seventy guineas per annum to take a school at Williamsburg, Va. After giving this offer serious consideration, he declined, and continued his studies at Yale. He completed the work for his master's degree in September 1788 and again participated in the commencement exercises—Master Wadsworth debating against Master Miller, a fellow candidate for the degree.

It is quite possible that Master Wadsworth was further imbued with the idea of a military career during this latter period at Yale. He was much in the company of President Stiles, and the "Literary Diary" of that distinguished educator is filled with references to Shay's Rebellion and the activities of General Lincoln and his state troops. But the time was not opportune, for the loosely united Confederation of States had practically no Regular Army, and military service offered no inducement to an exceptionally well educated, ambitious young man. During his stay at New Haven, Decius had met Judge John Trumbull, a lawyer and poet, and one of the leaders of the Connecticut group of early United States literary figures known as the "Hartford Wits." Trumbull's "M'Fingal," though not published until 1782, is credited with contributing to the progress of the American Revolution. Joel Barlow, author of the clever "Hasty-Pudding," was another member of this group of writers of satires and essays.

Much impressed by Judge Trumbull and his associates, and probably impelled by a desire to associate with men of such standing, Wadsworth decided to embark upon a legal career. After receiving his master's degree he began the study of law under Judge Trumbull. But the law was not for young Wadsworth. The judicial temperament was not his. As he so aptly put it, "That profession was uncongenial with my feelings."[2] He was an organizer, an administrator, with the spirit and temperament of a crusader, and he was living in a changing world. While he was studying with Judge Trumbull, the Constitution was ratified, Washington became President, a Department of War was established in the new Federal Government, and the Army began to show signs of life.

Having decided against the law, Wadsworth cast his eyes toward the Army as a profession. Anthony Wayne's successes in the Northwest Territory were attracting attention, and to the feeble Army of the young Republic, Congress, in 1794, added a new corps, to be known as the Corps of Artillerists

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This is Part I of the article; it will be concluded in Part II. The author gratefully acknowledges the valuable assistance of Col. E. L. White, Ord. Dept., in obtaining data on Colonel Wadsworth.

1. References will be published in full at the end of Part II.

and Engineers. Decius directed his efforts toward obtaining a commission in this newly formed organization. In this he was successful and, on June 2, 1794, was appointed by President Washington as a captain in the Corps of Artillerists and Engineers.[12] This corps constituted what is now our Coast and Field Artillery, Ordnance Department, and Corps of Engineers, having absorbed the four artillery companies already in the service.[3] For such an assignment Captain Wadsworth was eminently fitted, both by nature and by training. However, the next two years were dull ones for the Army and equally so for the ambitious new captain.

When, in 1796, the Army was reduced to four regiments of Infantry, two companies of Light Dragoons, and the Corps of Artillerists and Engineers,[3] with consequent demotions for many and stagnation in promotion for all, Captain Wadsworth submitted his resignation, effective July 19, 1796.[12]

IN the spring of 1798 war fever again spread over the United States. The impending war with France caused a frenzy of legislation. The Corps of Artillerists and Engineers was increased by three regiments and more than a million dollars was appropriated by Congress for harbor defense, new fortifications, and cannon.[3] Decius Wadsworth, being an opportunist, grasped this chance for active service and promotion and again applied to President Washington, then in his last year in office, for a commission. He was reappointed a captain in the Corps of Artillerists and Engineers on June 1, 1798.[12]

Preparation for war continued throughout the year 1799 and Captain Wadsworth was given ample opportunity to display his skill and ingenuity. His ability was quickly recognized, and on January 9, 1800, less than two years after his return to the service, he was promoted to the grade of major in the 2nd Artillerists and Engineers.[12] But shortly thereafter the situation changed. The French war clouds lifted. The inevitable reduction of the armed forces followed. On March 16, 1802, Congress reduced the Army to but two regiments of Infantry and one regiment of Artillery, and created a separate Corps of Engineers. This Corps of Engineers was authorized one major, two captains, and four lieutenants.[3]

Major Wadsworth survived this reduction, being retained as a major of Artillerists.[12] Preferring the Corps of Engineers to the Artillery, Major Wadsworth went to Washington in June of that year to persuade Maj. Gen. Henry Dearborn, Secretary of War under President Jefferson, to approve his transfer. The difficulty to be surmounted was that Major Wadsworth was senior to Major Jonathan Williams, the Principal Engineer and only field officer in the Corps of Engineers. So successful was Wadsworth in his endeavor that the President promoted Williams to the grade of lieutenant colonel and approved Wadsworth's transfer. On July 8, 1802, he was transferred to the Engineers and accordingly directed to "repair to West Point and join the Corps."[5]

The act which created the Corps of Engineers as a separate body stated that the Corps would be stationed at West Point and would constitute a military academy. Although stationed at West Point, Major Wadsworth usually spent much of his time inspecting and constructing fortifications. Immediately after reporting to Colonel Williams at West Point he was ordered to Fort Nelson, in Virginia, to supervise construction and renovation at that post. While Wadsworth was in Virginia a controversy arose between Colonel Williams, the Principal Engineer, and Capt. George Izard of the Artillerist regiment, also stationed at West Point, concerning the right of Colonel Williams to exercise command over the artillerymen.

Colonel Williams contended that as most of the officers of the Corps of Engineers had been selected from line organizations they were entitled to command according to their rank, when stationed with line troops. In this contention Colonel Williams was supported by Major Wadsworth and the remaining officers of the Corps. This controversy reached such proportions that it was referred to the Secretary of War for decision. To the surprise and chagrin of the Engineer officers, General Dearborn ruled against them. "The Corps of Engineers, as organized, being composed mostly of officers, and being engaged in scientific pursuits, should not exercise command in the line, unless by special assignment of the President."[6]

In January 1803, while this controversy was raging, Major Wadsworth was authorized to leave Fort Nelson, where the work had been suspended for the winter, and return to West Point. On his way north he stopped at Washington to consult with General Dearborn.[5]

IN the spring of 1803, Major Wadsworth was ordered to Fort Adams, near Newport, R. I., to construct new fortifications. While there he was advised by General Wilkinson, commander of the Northern District, that he was to be placed in temporary command of Fort Adams, pending the arrival of a field officer of the Artillery. Shortly thereafter he received a letter from the Secretary of War, dated June 21, 1803, advising him that Lieutenant Colonel Williams had resigned as Principal Engineer, due to the controversy over rank, and advising him not to assume command of Fort Adams. "I should advise you to decline the command and attend merely to your duties as an engineer. . . . It is the wish of the Executive that the gentlemen who have received appointments in the Corps of Engineers should devote their time and attention exclusively to the theory and practice of their profession, by which means we may avoid the unpleasant necessity of employing foreigners as Engineers,"[5] wrote General Dearborn.

In this epistle, the Secretary of War propounded his theory on the rights of command in the Corps of Engineers and added, "I should be much mortified by your following the example of Colonel Williams. I hope and trust you will be satisfied with the correctness of the principle adopted." The Secretary of War was not mortified at this time by Major Wadsworth's resignation, but did receive a strongly worded letter assuring the Secretary he was accepting the temporary command of Fort Adams and reasserting his right to command in the Army, "agreeable to his rank and the terms of his commission."[5]

Upon the resignation of Lieutenant Colonel Williams, Major Wadsworth automatically assumed command of the Corps of Engineers and became Principal Engineer. The act of March 16, 1802, which created the Corps of Engineers and the Military Academy, states, "The Principal Engineer, and in his absence, the next in rank, shall have the superintendence of said Military Academy." It is interesting to note at this point that the future first Chief of Ordnance had served thus previously as the second Chief of Engineers and as the second Superintendent of the Military Academy. A letter from the Secretary of War, dated June 21, 1803 (the date of Williams' resignation and of the letter to Wads-

worth at Fort Adams) to Capt. William A. Baron, the senior Engineer officer at West Point at that time, says, "Lieutenant Colonel Williams having resigned, the direction of the Military Academy will necessarily be under your care during the absence of Major Wadsworth."[7]

In July 1803, Major Wadsworth was advised of the Louisiana Purchase. He was directed to suspend work at Fort Adams and to prepare to proceed to New Orleans to inspect defenses at that city, "New Orleans, with the whole of Louisiana, being by treaty ceded to the United States, possession of which will probably be obtained the ensuing autumn . . .,"[7] explained General Dearborn in his communication. In compliance with these instructions, Major Wadsworth set forth for New Orleans and by February of 1804 was rendering detailed reports to the Secretary of War on his survey of the entire lower Louisiana area. His reports, with characteristic thoroughness, covered the cost of brick, shingles, stone, and other building material, and discoursed on the labor situation.[7]

In June of the same year, Major Wadsworth returned to West Point for the first time since he had been the Principal Engineer, and assumed command of that post and the Academy, as is shown by the return for the Corps of Engineers at that post as of June 7, 1804.[7]

The Army of the early nineteenth century was not distinguished for its discipline. Decius Wadsworth was among the most outspoken of his time. Upon his return to West Point he resumed the fight for equal right of command for Engineer officers. Believing his cause a just one, he and the other officers of the Corps went over the head of the Secretary of War and addressed a memorial to the President of the United States.[6] In this communication they stated the Secretary of War had no authority to deprive them of their lawful prerogative, and asked for a reversal of General Dearborn's decision.

Confident the President would correct this obvious injustice, Major Wadsworth made preparations for his return to New Orleans to supervise the construction of the new fortifications at that place. On December 31, 1804, he wrote the War Department relative to his orders for New Orleans and requested his accounts at West Point be settled before his departure. He also proposed to sell sundry books for use of the Military Academy.[7]

January passed and still no answer to the memorial to the President. Wadsworth felt the Corps had been offered a deliberate affront which his pride would not permit it to suffer. On January 31st, writing from his headquarters at West Point, he, for the second time in his career, resigned his commission.[7] His resignation was accepted February 8, 1805, the Secretary of War writing, "It is with regret that your resignation has been received . . . there will be no disposition to take any advantage of your being under orders for New Orleans. . . . Please accept my best wishes for your happiness through life."[7]

Wadsworth's resignation, following so closely upon that of Colonel Williams, apparently impressed the Secretary of War with the necessity of remedying the situation, and soon a compromise agreement was reached which was satisfactory to the remaining officers of the Corps. Colonel Williams accepted the terms of this compromise and was reappointed as a lieutenant colonel in the Corps of Engineers as of April 19, 1805. Major Wadsworth, however, did not accept reappointment. Later, when he was Chief of Ordnance and General Dearborn commanded the Northern Army, he was critical of practically all of General Dearborn's activities, and openly hostile to some.

A friend of Wadsworth's, in referring to his resignation said, "The country having regained its tranquillity . . . and there being no prospect for a speedy call for the display of military talents, he resigned."[2] The truth is that Wadsworth had the courage of his convictions. The officers of the Corps of Engineers had, in his opinion, been done a grave injustice. Being a natural crusader he could not compromise.

AT the age of thirty-seven, after spending more than nine years in the service of his country, Decius Wadsworth was again faced with the problem of deciding upon another career. Having found the law "uncongenial with his feelings" and the discipline of peacetime soldiering galling to his pride, he turned to commercial pursuits. In the summer of 1805 he moved to Montreal, where he engaged in the mercantile business. In this activity his genius for organization, abounding energy, and keen mind were unfettered by regulations. Although highly opinionated, self-willed, and dominating in manner, his frankness and unquestioned integrity made him many friends, and his business prospered.[2]

Shortly after entering business in Montreal, Decius Wadsworth developed an ailment which greatly impaired his activities for the remainder of his life. About 1806 a small wart appeared on one of his fingers, but for a year or so it gave him no pain or uneasiness. As it grew in size he thoughtlessly formed the habit of cutting or paring it with his pocket knife. From this small start a painful ulcer developed which eventually caused his death.[2]

Of Wadsworth's seven years in commerce there is little of interest. By the spring of 1812 trouble again was brewing for the young nation. This time it was with England, and war seemed inevitable. A large portion of the nation, particularly the new West, clamored for war, and on May 14, 1812, Congress passed an act reorganizing the Army. This act created the Ordnance Department as a separate department and authorized a commissary general of ordnance as its head, with the rank, pay, and emoluments of a colonel of Infantry.

On June 18, 1812, before the new department could be organized, war formally was declared against Great Britain. It was essential that an experienced and capable man be found to assume the responsibilities inherent to the new office. Bearing in mind Wadsworth's efficient service in the Engineer Corps, Dr. William Eustis, then Secretary of War, wrote him on July 3rd, notifying him he had been selected as Commissary General of Ordnance and proffering the commission of colonel. Allowing but a few days to close his business activities, Wadsworth promptly accepted the assignment. Writing from New York on July 18th, he said, "I have been honored. . . . I accept the appointment and believe it will be in my power to set off for the seat of government on Monday next."[4]

Arriving in Washington, Colonel Wadsworth found conditions in the Army deplorable. The Army had been allowed to dwindle to approximately 7,000 men,[3] most of whom were scattered along the frontier and the coast. The Treasury was depleted, military stores and equipment were exhausted, only two national armories were in existence, and their capacity for the manufacture of muskets was extremely limited. The problem was further complicated by the complete lack of standardization of equipment throughout the service. Congress had endeavored to meet the situation by authorizing a volunteer Army of 30,000 men, but the in-

ducements offered were so meager that enlistments could not be obtained. Congress then called upon the governors of the several states to raise a militia force of 80,000 officers and men and have them ready to march at once,[3] ignoring their need for adequate arms and equipment.

COLONEL WADSWORTH found his newly authorized but unorganized department charged with the responsibility for the procurement, supply, and maintenance of all cannon, their carriages and equipment, hand and side arms, powder, ball, shot, and other items for this force which was being hurriedly assembled. His first official act was the organization of his department and the assignment of his assistants to the most strategic locations.

His own headquarters were established in Washington to be near the seat of government. Capt. John Morton, a deputy commissary, was selected as his assistant. Several magazines and arsenal buildings already were located on Greenleaf's Point, now the site of the Army War College, and this arsenal was developed further. The Columbia Foundry, located in Georgetown on Foundry Branch near the present site of Glover Park and operated by Henry Foxall, was selected as the principal source of cannon. Col. Louis de Tousard, in his "American Artillerists' Companion," refers to this foundry and to Cecil Furnace, in Maryland.

Maj. George Bomford was appointed Assistant Commissary General of Ordnance and stationed at Albany, the most favorable location for the supply of the Northern Army. This arsenal also was selected as the principal establishment for making fixed ammunition for small arms and all small articles of equipment for a train of artillery. Pittsburgh was selected as the principal arsenal of construction for gun carriages because of the excellence of the carriage workmanship of the men in Pennsylvania and the high quality of material available. Capt. Abraham R. Woolley, another deputy commissary, commanded this arsenal which was also the main source of supply for the troops along the Ohio River and the Great Lakes.

The immediate installation of these two arsenals was necessitated by the American policy of invading Canada. Those in authority apparently could not or would not comprehend the untrained condition of the soldiers, their unwillingness to cross the border, or the complete absence of good roads to the Canadian boundary. This policy made heavy drains on the meager supplies available and created stupendous transportation problems. The ambition to invade Canada at the expense of other necessary defense measures was encouraged by General Dearborn, who in turn was probably actuated by a desire for revenge, having been made a prisoner at Quebec in 1775 when a captain in the New Hampshire Militia.

The supply and maintenance of muskets was another problem which demanded immediate attention. Large quantities of damaged muskets were on hand, and the number was increasing daily due to lack of field maintenance. Weapons originally withdrawn for only a minor fault would arrive at the public stores in a useless condition. This condition Colonel Wadsworth proposed to remedy by furnishing armorers to accompany the troops, or have each organization with its own armorer, and furnish them with the parts for field repairs.

Having served in the Artillery and knowing their resentment of the authority delegated to the new department, Colonel Wadsworth anticipated conflict with the officers of that arm. He immediately appealed to the Secretary of War to clearly settle and define the duties and responsibilities of each branch, so friction and dispute might be avoided. However, that dignitary did not see fit to clarify the situation. As a result, innumerable quarrels and disagreements occurred over almost every activity in which the new Ordnance Department and the Artillery came in contact. Colonel Wadsworth recommended the reduction of the calibers of cannon to five; namely, 3-, 6-, 12-, 18-, and 24-pounders, with two calibers of howitzers and two of mortars. This would simplify the supply of both cannon and ammunition. This recommendation was vigorously opposed by the Artillery, as were a number of other efforts to simplify and standardize the design of both cannon and carriages.

HULL'S surrender of Detroit on August 16th, with its accompanying loss of matériel, so laboriously accumulated, was a heavy blow to the new department. Van Rensselaer, Smythe, and Dearborn each in turn made heavy demands on the Ordnance Department for matériel and ammunition for their proposed invasions of Montreal, and each in turn failed in the attempt.

Colonel Wadsworth openly criticized these activities and the extravagance of their demands. He even appealed to the Secretary of War to require all requisitions to be approved by the War Department.[8] He was particularly critical of one estimate made by General Dearborn for small-arms ammunition which represented about nine months' output of the arsenal at Albany. On this subject he wrote: "Every general officer holding a separate command who, anxious each for his own reputation, seeks to multiply his means for offense and defense almost without end . . . more particularly as the requisitions, for want of sufficient knowledge, or due consideration, are not always made of just proportions."[8]

After the surrender of Hull and the successive failures of Van Rensselaer, Smythe, and Dearborn, Secretary Eustis resigned. In February 1813, President Madison appointed Gen. John Armstrong as his successor. Armstrong, with the proverbial efficiency of the new broom, promptly organized the nation into nine military districts and ordered General Wilkinson from New Orleans to Sacketts Harbor to command the Northern Army. This new organization so closely paralleled the supply organization established by Colonel Wadsworth that practically no change was made in the latter. The arsenal at Albany under Major Bomford supplying General Wilkinson's Ninth District and that at Pittsburgh under Captain Woolley, supplying General Bloomfield's Fourth District, continued to be the busiest arsenals, although attention was focused on other activities.

By this time the people of Norfolk and the central seaboard were thoroughly alarmed by the success of the British blockade of the Chesapeake and the Delaware and the ever-present threat of an attack. In May 1813, a small British force, numbering approximately 500 men, under Adm. Sir George Cockburn, landed near the mouth of the Susquehanna. They burned and pillaged the neighboring towns, thoroughly frightening the inhabitants. The first effect of this raid upon Colonel Wadsworth and the Ordnance Department was the loss of Cecil Furnace, a foundry used for the casting of cannon. This was destroyed by Cockburn during the raid, with the loss of many castings. This raid and the attack upon Norfolk, which occurred a few weeks later, put fear into the entire seaboard, resulting in incessant demands for additional fortifications. (*To be concluded.*)

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MAY-JUNE, 1943

The Battle of Production

A Résumé

December Production.—The true achievement of American industry at war is indicated by its accomplishments in munitions production during the months of December, January, and February. Output of munitions in the month of December rose fourteen per cent above November, attaining a level nearly five times that of November 1941, the month before Pearl Harbor. Despite all obstacles, the volume of planes, tanks, guns, and ships turned out by U. S. factories in December was the greatest ever produced in one month. And December's fourteen per cent gain was the greatest for any one month.

While a part of this remarkable rise resulted from a year-end drive to clear up odds and ends, two other records indicated that the industrial pace did not slacken as we moved into 1943: (1) An all-time monthly record for steel-plate production was established in January when 1,135,413 tons of plates were shipped by the nation's steel mills. (2) For the second consecutive month, American shipyards added more than a million tons of shipping to the Victory Fleet, with delivery of 106 vessels totaling approximately 1,008,400 dead-weight tons in January.

Busy meeting the huge requirements of total war, the U. S. oil industry did not carry forward the normally extensive new exploration operations last year. Consequently, new discoveries again fell far short of actual consumption. Though not immediately alarming, this means that the nation is depleting its known oil reserve during a period of life-and-death struggle. Long sustained, such a trend could be serious.

January Production.—In January, more than 70,000 aircraft bombs of 1,000-pound size or larger were produced by American industry—enough to bomb the enemy at the rate of 2,300 a day for 30 days. Aircraft production for the month was approximately 5,000 airplanes, of which more than 65 per cent were of combat type. Procurement of equipment for the Ground and Air Forces climbed steadily at an average rate of nearly $100,000,000 a month during 1942. Production for January 1943, was 3½ times the rate of January 1942. Although somewhat below the production for December 1942, as a result of anticipated fluctuations caused by year-end adjustments, January was nevertheless in line with the scheduled long-term upward trend.

In January also, many new or recently modified items were either just entering into production or their mass production was beginning to be effective. An example of this is seen in the January output of more than 58,000 carbines. Other important items which had been in mass production for some time began to reach their planned maximum monthly rate. During January there were turned out more than 80,000 Garand rifles, 27,000 caliber .50 aircraft machine guns, 7,000 twenty-mm. aircraft cannon, and 68,000 submachine guns. More than 37,000,000 square feet of metal landing mats were also produced for airfields during the month.

A total of 26,000 new machine-tool units, valued at $117,432,000, were shipped during January—a reduction of 11 per cent from the December figure of $131,960,000.

February Production.—Production picked up substantially in February, and average daily expenditures by Government agencies for war purposes reached a new high of $253,400,000. Preliminary reports on February production of munitions indicated an increase of about eight per cent over January output, following the eight per cent decline in the previous month. December remains the record month because of the year-end clean-up of assembly lines, but the daily rate of production in February, a short month, was six per cent greater than the December daily rate.

The upward trend is disclosed by comparing 3-month averages. Average of the Index of Munitions Production for the 3 months ended in November is 397. Average for the 3 months ended in December is 439; for the 3 months ended in January, 463; and for the 3 months ended in February, 482.

In February, America produced 1,932,000 high-explosive shells of all calibers. This is a rate of fifty shells a minute, day and night, for the month. In the same period, our shops and arsenals produced 419,000 bombs in all sizes up to block busters, enough to drop 15,000 a night on enemy ships and cities. We made 8,000 cannon for aircraft, 2,000 antiaircraft guns.

Industry hung up a new record for small-arms ammunition in February with a total of 1,244,000,000 cartridges in

calibers .30, .45, and .50. This is a rate of more than 500 cartridges a second for every second in the month.

In January and February, American shops produced 150,000 machine guns and 134,000 submachine guns as against 132,000 machine guns of all calibers produced during the entire World War. In these two months we produced 5,000 tanks, more than 28,000 army trucks, 2,000 antitank guns, 5,000,000 pairs of marching shoes. In February alone, 7,800 weapon-bearing combat vehicles were manufactured. The production rate on rifles, carbines, artillery, and radio equipment continues to rise steadily, and, in February, production of matériel and supplies for war was 300 per cent higher than a year ago, giving promise that industry will fulfill this year's $57,000,000,000 program.

Ships.—Outstanding progress in construction of merchant ships, warships, and naval aircraft also was reported. Navy Secretary Knox announced that construction of warships and naval planes in February was larger than any other month in Navy history. Earlier, the Maritime Commission revealed a new record in February for delivery of cargo ships also.

Combat surface vessels alone completed during February approximated 200,000 tons, representing more than 130 new ships and 20 cargo ships converted into war vessels. Aircraft construction set a Navy record, with nearly 1,400 new airplanes accepted, of which considerably more than 50 per cent were combat types. In addition to the warcraft tonnage, more than 700 landing craft were accepted, of which above 100 were "large" landing boats.

In an annual report to the President covering fiscal year 1942, Mr. Knox pointed out: "The over-all ship-production program was scheduled for completion in 1947, but speeded-up construction has broken all previous records, and it is now expected that, except for some large units upon which work has been suspended due to material shortages and the length of time required to build, the entire authorized tonnage will have been commissioned and put into active service before the close of 1945."

The Maritime Commission announcement said American shipyards during February surpassed all previous ship-construction records by delivering into service 130 new ships totaling approximately 1,239,200 dead-weight tons. Of these vessels, 81 were Liberty ships, 15 C-type cargo, 9 tankers, 23 special types, 1 concrete barge, and 1 coastal cargo ship. This brought the total number of vessels constructed thus far in 1943 to 233, totaling 2,247,600 dead-weight tons. Thus, the number of ships delivered during January and February already exceeds the number delivered during the first six months of last year.

Another important shipping development is the program for building a new type of destroyer-escort vessel for protection of convoys against submarines. Several score have been launched and equipment for them is being rushed as fast as possible. The destroyer-escort will not replace corvettes despite their superior speed, seaworthiness, and firepower. The corvette program will continue as now laid down.

Designed to operate in teams in escorting convoys, the destroyer-escorts will be manned by crews now undergoing special training for this arduous and exacting work. The vessels will release destroyers from convoy duty for other service where their qualities can be more fully used.

The cost of destroyer-escorts will be about $3,500,000, roughly half that of a destroyer. These new vessels displace about 1,300 tons, are approximately 300 feet long, with a beam of 35 or 36 feet. Thus they are considerably smaller than modern destroyers and about the size of destroyers in the last war. They are capable of fighting it out with submarines on the surface also.

New Programs.—Planned production will increase output of necessary war and civilian materials and obtain more efficient use of man power, according to Donald M. Nelson, chairman of WPB. He explained that under the plan being developed by himself and Vice-Chairman Charles E. Wilson, production probably can be stepped up as much as twenty per cent this year. He does not anticipate any difficulty in equipping an armed force of 11,000,000 men.

"I think the problems of the conflicting components in the 'must' programs are being approached very vigorously and are being licked," he said. The five "must programs" are synthetic rubber, high-octane gas, merchant vessels, escort vessels, and airplanes. "I think we can get an extra twenty per cent of production—I am sure it will be gotten. I think we can get today about twenty per cent increased production over what we could otherwise get through the orderly handling of component parts and raw materials; being sure that they are there on time, but not too far ahead of time and not in quantities that are merely held in reserve, waiting for the time they will be used. . ."

The new emphasis on ships and planes will have a marked effect on the production picture. On this point, the Philadelphia *Inquirer* offers the following interesting comment:

> It would be most unwise for the Axis to assume from the published announcement of substantial modifications in our war production program that we are pulling any punches. The object is to make America's punches tougher. Here's the picture: Our national output of planes in 1943 is to be twice the number and four times the weight of planes built last year. Recalling Lieutenant General Arnold's recent remark that the present hard-hitting Flying Fortresses and Liberators are "perhaps the last of the small bombers," we may realize partially what the huge new aircraft program means. Construction of new factories for other purposes will be discontinued and new airplane plants and facilities will be increased. Smaller programs for tanks, artillery, motor vehicles, ammunition, and some other war items in which the tempo is apparently adequate for present and prospective requirements, are contemplated. These changes of emphasis should assist to some extent in the industrial man-power situation and certainly overcome some important problems of allocating materials. They signify also our determination to win the crucial battle of transportation this year and to deliver hammer blows at our enemies, East and West, with mighty sea and air fleets.

Already, reports of combat in Africa and the Southwest Pacific seem to be bearing out the wisdom of this decision. If further changes should be needed later, American industry has proved itself ready and able to respond to any challenge with enough production—and on time.

There Will Always Be an Ordnance Department

An Editorial

ORDNANCE was one of the first and most urgent needs of the rebellious Colonies in 1775. Almost entirely lacking manufacturing facilities, they were hard put to it to acquire munitions. On May 27, 1775, the Continental Congress appointed a committee to consider ways and means of supplying the Colonies with ammunition and military stores. The need for powder was met by crude manufacture throughout the Colonies and by the capture of British supply ships. The need for cannon in the siege of Boston was met by Ethan Allen's capture of Ticonderoga on May 10, 1775, anticipating congressional action by seventeen days and illustrating the merit of individual authority versus "committee" action.

Soon after the close of the Revolution, a committee of Congress (an early postwar investigation!) in its report referred to the "Ordnance Department" as "important and interesting to the Union." But like all things military, Ordnance suffered from the postwar demobilization. It was not until 1812, when difficulties with the British again occupied our attention, that the need for a separate body of specialists devoted to the development and supply of instruments of war became sufficiently apparent to result in the creation of a permanent Ordnance Department by the Act of May 14, 1812. The present issue of ARMY ORDNANCE, therefore, celebrates the 131st birthday of the Ordnance Department.

The first Chief of Ordnance was Decius Wadsworth of Connecticut. (His official title was Commissary General of Ordnance and his rank that of colonel.) Much of the early history of the Department and the difficulties confronting it can be visualized from Colonel Reed's article on "Decius Wadsworth" which begins in this issue (p. 527). Suffice it to note here that he assigned his assistants "to the most strategic locations from a viewpoint of both procurement and supply," that he instituted field maintenance, and endeavored to promote standardization of weapons and the equitable distribution of available munitions. Similar problems still confront the Department. *Plus çà change, plus c'est la même chose!*

By the very nature of its work, the Ordnance Department is fated to be the target of criticism. The development of matériel of new types cannot be carried on in a "goldfish bowl" if we are to avoid giving our enemies the benefit of our own enterprise. The heavy tank is a case in point. When General Rommel recently brought his 55-ton monsters against the American lines in Tunisia, a wave of criticism of the Ordnance Department swept through editorial pages and columnists' columns because our men did not have immediately at hand similar weapons to meet them. No recognition was given to the fact that, even if we had had them in Africa, tactical considerations might have caused them to be elsewhere at the moment of Rommel's attack. The facts that we had built such tanks and that our Armored Force had experimented with them and decided against their use were not a matter of public knowledge at the moment. It was left to General Rommel to discover the hard way that such behemoths have limited use on present-day battlefields.

A somewhat different illustration is that of the Garand rifle. Only a few months ago, severe public criticism was laid on the Department because of the adoption of that weapon. This had openly been under development for several years; it had been tested and retested by the Army and the Marine Corps. Nevertheless, the judgment of those concerned with its development and adoption was widely challenged in no uncertain terms. Today, the story is different. There have even been rumors of soldiers sleeping with their Garands to prevent others less fortunately armed running off with them in the night, leaving the old Springfield in their place.

There is no reason to object to such uninformed criticism. It is only a phase of the workings of a democracy. Perhaps one should take refuge in the philosophy of David Harum: "A reasonable amount of fleas is good for a dog. They keep him from broodin' on bein' a dog." Even uninformed and unwarranted criticism does perform the function of keeping all concerned on their mettle.

However, the best cure for such criticism is to make public, in so far as national interest will permit, information concerning our material, the reasons for its development and manufacture, and the nature of its performance in the field. General Campbell's article in this issue (p. 493) is of this nature. The frankness with which he discusses certain of our newer weapons should convince the public of the soundness of the work of our Department and give it confidence in what cannot at present be revealed.

"THE past is but prologue." For good or evil, what has happened before today cannot be changed, but it does furnish the only guide which we have to pilot our way toward the unknown future. The problems which confronted Colonel Wadsworth in 1812 have merely become broadened and intensified in 1943. Certain it is that ordnance will continually assume greater and greater relative importance as science and technique advance and industry and the world in general become continually more highly organized and mechanized. Indeed, the one beneficial by-product of war is the tremendous stimulus given such evolution. Some of the products of this evolution which must be worked into our postwar economy, military as well as civilian, are indicated by Colonel Herrington's article in this issue (p. 496) on the rôle of industry in our postwar world. It is obvious, almost to the point of being banal, that the necessity of perpetuating the present intimate Industry-Ordnance team through the postwar era is of transcendent importance. We dare not wait for the potential military applications to be pioneered elsewhere.

The elements required by the problem are simple. They are (1) direct contact and coöperation between science, industry, and the various subdivisions of the Department; (2) sufficient funds to permit the full exploitation of all things which offer prospect of being of military value from (a) invention through (b) development and test of pilots to (c) quantity production and complete test of the final product by the using services. Not the least in importance is (3) freedom, for those having the capacity, to perform their functions with the minimum amount of supervisory control necessary. Such freedom will insure that their work will result in giving the using services what they want rather than what nonusers may think they ought to have.

Association Affairs

Boston Post

ONE of the largest and most successful meetings ever held by a local chapter of the Army Ordnance Association was sponsored by the Boston Post on Friday, April 2, 1943, at the Hotel Statler, Boston, Mass. This meeting, like the five previous annual gatherings, was also sponsored jointly by the Boston Chapter of the American Society for Metals, the Associated Industries of Massachusetts, the New England Council, and the Advertising Club of Boston. More than 3,000 persons visited the ordnance displays which were exhibited at the Hotel Statler during the afternoon, and approximately 1,200 attended the dinner which climaxed the meeting.

The proceedings opened in the afternoon with panel discussions on "Substitutes and Emergency Steels," and "Ordnance Inspection." The ordnance displays included the latest combat equipment for soldiers in the field, a light tank, and a 90-mm. antiaircraft gun. Ordnance items manufactured in the Boston Ordnance District were also on display, the various steps in manufacture being shown in many cases by sectionalized components and other methods.

Brig. Gen. H. F. Safford, chief of the Production Service Branch, Office of the Chief of Ordnance, was the principal speaker at the dinner which was held in the main ballroom of the Statler. General Safford, who had recently returned from scenes of action in England and Africa, in speaking on production and battle experience, said:

"It must be remembered in this war that the United States is not supplying the U. S. Army alone; it is supplying the land, sea, and air forces of the United Nations, as well as a considerable portion of their civilian requirements. Our materials must go to Russia to provide the essentials without which her present successful campaign would be impossible. They must go to China, to Africa, to England, to Australia, and the farthermost corners of the world. If we fail, battles are lost and men die."

He revealed that from a production rate of $1,000,000 a month in May 1940, ordnance manufacture has expanded 700 per cent in two short years, to $700,000,000 a month, "a miracle of production surpassing, in two short years, the mass production of the Axis over a 10-year period."

Col. Winthrop Sargent, Jr., representing Brig. Gen. Burton O. Lewis, chief of the Boston Ordnance District who could not be present because of illness, also spoke, telling how New England industry has adapted itself to war production. He said in part:

"Producers of machinery for the textile industry and producers of other machinery in this area have come forth with artillery items, a wide variety of shot and shell, and other metal ammunition components, and, in addition, complete automatic rifles.

"Manufacturers of artificial teeth have converted their facilities to the manufacture of perishable tools, and producers of tombstones are now producing tank wrenches. Silversmiths have turned their equipment to the manufacture of cartridge cases. Toy manufacturers are making shells and fuzes. Manufacturers of jewelry are producing fuzes for bombs. Manufacturers of perfume atomizers are producing metal components of artillery ammunition. Such conversion is the rule rather than the exception."

Hon. Maurice J. Tobin, mayor of Boston, and Hon. Leverett Saltonall, governor of Massachusetts, also addressed the meeting, extending the greetings and felicitations of the city and state. Capt. William J. Hennon, flight commander of the 21st Army Fighter Squadron, and Lieut. Eugene S. Bosch, of the Ordnance Department, told of actual experiences in battlefront operations. Other speakers were A. J. McDuff, chairman of the Boston Chapter of the American Society for Metals; Ira Mosher, president of the Associated Industries of Massachusetts; and Lieut. Col. C. S. Robinson, of the Boston Ordnance District. The toastmaster was William M. Rand, vice-president of Monsanto Chemical Company.

Among the guests of honor present at the dinner were the following: J. V. Baxter, vice-chairman, Boston Chapter, American Society for Metals; Edward E. Chase, president, the New England Council; Dr. Donald K. David, dean, Harvard Business School; John C. Garand, inventor of the Garand rifle, Springfield Armory; Col. John Mather, commanding officer, Watertown Arsenal; Col. Earl McFarland, commanding officer, Springfield Armory; Henry J. Nichols, vice-president, National Shawmut Bank of Boston and president, Boston Chamber of Commerce; Col. Frederick H. Payne, assistant district chief, Springfield Ordnance District and vice-president of the Army Ordnance Association; Brig. Gen. R. H. Somers, U. S. Army, Ret., executive secretary, Army Ordnance Association; Col. Charles H. Tenney, a member of the advisory board of the Boston Ordnance District and a director of the Army Ordnance Association; Roy F. Williams, general manager, Associated Industries of Massachusetts; Dr. R. S. Williams, deputy dean of engineering, Massachusetts Institute of Technology.

General Lewis was honorary chairman of the committee in charge of arrangements for the meeting. F. W. Knauth was acting chairman assisted by Capt. W. J. Peterson, John M. B. Churchill, Augustine J. Rooney, and Miss Evelyn Woodbury of the Boston Ordnance District Office. Col. Mather and Col. Wallace A. Moyle, of the First Service Command, rendered invaluable service in connection with the ordnance displays.

Cincinnati Post

THE Cincinnati Post was host to another great turnout on March 27th when 800 persons attended the Post's annual dinner at the Netherland Plaza Hotel in Cincinnati. The principal address was delivered by Maj. Gen. Levin H. Campbell, Jr., Chief of Ordnance, whose speech was broadcast over the Red Network of the National Broadcasting Corporation. General Campbell's address is published on page 493 of this issue. Brig. Gen. R. H. Somers, U. S. Army, Ret., executive secretary of the Army Ordnance Association, also spoke briefly. Mr. Harvey C. Knowles, president of the Cincinnati Post, was toastmaster.

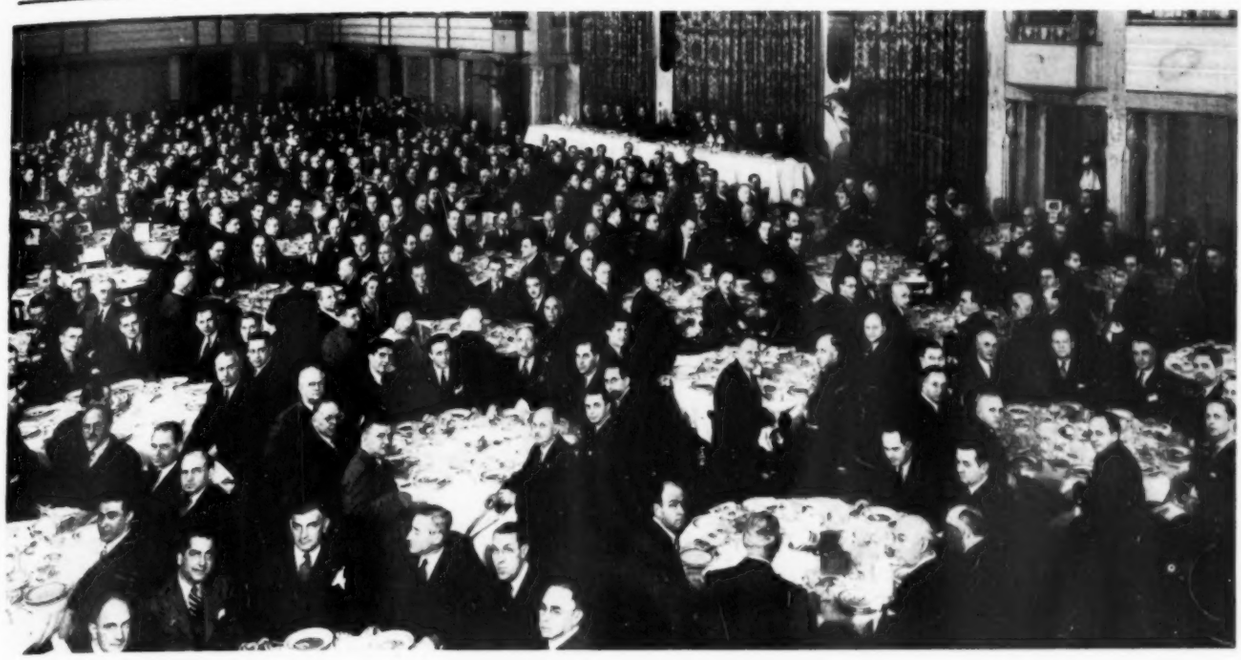
Among the other guests of honor were Col. Fred A. McMahon, chief of the Cincinnati Ordnance District and secretary of the Cincinnati Post; Lieut. Col. Joseph C. Shouvlin, deputy district chief; Lieut. Col. William R. Martin, executive officer of the district, and the following members of the Cincinnati District Advisory Board: H. C. Blackwell, J. C. Dinsmore, J. B. Doan, R. K. LeBlond, and J. J. Rowe.

New York Post

TO mark the official opening of an ordnance display in the showrooms of the Chrysler Building, the New York Post sponsored a "field-ration luncheon" on March 15th at the Commodore Hotel in New York City which was attended by more than 400 members of the Association, friends, and guests.

The luncheon, which consisted of the same types of food served to soldiers at the various Ordnance posts throughout the country, included tomato soup, stuffed green pepper, potatoes, ice cream, cake, and chocolate beverage. Proceeds of the luncheon above the actual cost were donated to Army Emergency Relief.

Speakers at the affair were Brig. Gen. Walter P. Boatwright, chief of the New York Ordnance District, and New York City Commissioner George A. Sloan, chairman of Mayor



SOME OF THE MEMBERS AND GUESTS WHO ATTENDED THE NEW YORK POST LUNCHEON

LaGuardia's Business Advisory Committee. R. E. Gillmor, president of the Post, was toastmaster.

Following the luncheon, members and guests visited the Chrysler Building for a preview of the ordnance display which was opened to the general public the next day. Arranged on two floors, the display included a 40-mm. Bofors antiaircra t gun emplaced behind a sandbag barricade and connected with its electrically controlled fire director; reconnaissance cars; a 75-mm. tank cannon in its armored mount; shells and fuzes of various types; 37-mm. antitank and antiaircraft guns, and other items of ordnance equipment.

40-MM. ANTIAIRCRAFT GUN ON DISPLAY IN NEW YORK

In opening the proceedings after the luncheon, Mr. Gillmor spoke in part as follows:

"This occasion symbolizes our dedication to victory. We have lunched on the Army field ration, thus indicating our willingness to live as our soldiers do. The exhibit takes place in the showrooms of a great automobile company, thus symboli ing the conversion of industry to war and the willingness of all Americans to forego everything except the bare necessities of life. The equipment in the exhibition is representative of the ingenuity and skill which is now being applied to give us the most powerful and best-equipped Army the world has ever seen.

"The exhibition will serve several important purposes; perhaps the most important is educational. There are millions of people in this community whose sons and brothers are dependent for their lives on equipment of this type. The exhibition will give them an opportunity to learn about it, to see its efficiency and ingenuity. There are tens of thousands in the community who have left other pursuits to participate in the manufacture of ordnance equipment and who, in many cases, do not know the function or even the name of the complete apparatus for which they are making parts. Industry is doing its best to give its personnel an understanding of the vitally important work they are doing, but the magnitude of the task makes it slow.

"Another important objective of the exhibit is to show the extent to which the New York District is producing ordnance equipment. The people of this great city are contributing enormously in this, as in other branches of the war effort. They will see at the Chrysler Building some of the tangible evidence of that contribution and the names of the companies who are engaged in it."

In his address, General Boatwright spoke in part as follows:

"Those of us who make up the Ordnance-Industry team charged with production and design of weapons of war are very keenly interested in knowing how our products are performing on the battlefield. For an authoritative answer, I turn to your own publication, ARMY ORDNANCE, and quote from an article in the current issue, written by the Secretary of War, Mr. Stimson: 'This Army of ours is being rapidly equipped with the best airplanes that are in the air today, with the best tanks that are on the ground today, with the best self-propelled artillery that is in action today, and with the best rifles—according to almost unanimous testimony—that are in use in any part of the world today, and its other equipment is of similar high standard.'

"The successful efforts of Ordnance and industry are due in great measure to the active support and tireless work of the Army Ordnance Association in peacetime and in war. It is, therefore, most fitting that the members of your Association be the first to observe and participate in the exhibit you will presently see."

The following are excerpts from the address of Commissioner Sloan:

"On behalf of Mayor LaGuardia and the City of New York, I wish to express to General Boatwright and to his associates in the New York Ordnance District our grateful appreciation for the splendid way in which they have coöperated with us in the war production program. Too often coöperation is a one-way affair. In this instance, it has meant realistic teamwork in placing war contracts in New York and tangible war production orders for countless small manufacturers.

"When Maj. Gen. Levin H. Campbell, Jr., was appointed Chief of Ordnance in Washington, one of the first problems to which he gave attention was the critical needs of New York City. Within a few days after his appointment, General Campbell came to New York and brought with him General Boatwright, who was to head this all-important district office. I had the pleasure of being with them when they called on Mayor LaGuardia, and from then on there has been an effective relationship between General Boatwright's office and the city administration."

Also seated at the speakers' table were Col. Charles Johnson, of Army Emergency Relief; Col. James E. McNary, vice-president and treasurer of the New York Post; Theodore Wright, of Chrysler Corporation; Brig. Gen. R. H. Somers, U. S. Army, Ret., executive secretary of the Army Ordnance Association. The committee in charge of the luncheon consisted of Maj. D. B. MacMaster, public relations officer of the New York Ordnance District; Gilbert H. Higgins, of R. Hoe & Company; and Lannon F. Mead, vice-president of Regina Corporation.

ANNUAL DIRECTORS' MEETING

THE annual meeting of the board of trustees and directors of the Association was held on February 11th at the University Club, New York City. The meeting was called to order by Brig. Gen. Benedict Crowell, Association president. The death of the late Maj. Gen. William Crozier, Association director who died on November 10, 1942, was announced by the president and it was unanimously resolved "That the officers and directors now pause in their deliberations and here record, in behalf of the Ordnance Department of the United States Army, the Army Ordnance Association, and the engineering professions dedicated to the national defense, the irreplaceable loss and deep sorrow felt by all patriotic Americans at the passing of an officer and gentleman who devoted all of his long life to selfless service of his country."

Brig. Gen. Chas. Elliot Warren, Association treasurer, in submitting his annual report analyzed the favorable financial condition of the Association as indicated by the audit made by Messrs. Ernst & Ernst.

Brig. Gen. R. H. Somers, executive secretary, then submitted his report on the activities of the Association for 1942, and Col. James L. Walsh, vice-president, reported on behalf of the committee on transportation.

General Somers then brought before the meeting proposed changes in the constitution and by-laws of the Association looking toward a broader organization with a wider field of activities. It was decided to submit the proposed revision of the constitution to the membership for the required letter ballot. This was done on March 29th; polls will close on Monday, May 3, 1943, at 12 o'clock noon. The principal changes recommended are: (1) Broadening the Association's objectives to include the advancement of all the armament of all our armed services; (2) Increasing the number of directors to be elected by the membership to secure a wider representation; (3) Changing the name of the "Board of Trustees" to "Executive Committee" and making it definitely subordinate to the board of directors. Results of the balloting will be announced in the next issue.

Besides General Crowell, General Somers, General Warren, and Colonel Walsh, the following officers and directors were present at the meeting: Col. William W. Coleman, and Col. Frederick H. Payne, vice-presidents; Brig. Gen. John Ross Delafield, counsel; and Col. Frank A. Scott, Col. Robert P. Lamont, Brig. Gen. Samuel McRoberts, Col. Herbert A. Gidney, Col. Arthur W. Herrington, Mr. Thomas A. Morgan, and Mr. George W. Elliott, directors.

By invitation of the board, Maj. Gen. C. C. Williams, World War Chief of Ordnance and formerly a director of the Association; Col. L. A. Codd, executive assistant to the Chief of Ordnance, formerly executive secretary of the Association; and Mr. Roger E. Lewis, associate editor of ARMY ORDNANCE were present at the meeting. Colonel Codd recently has been promoted to the rank of full colonel.

NECROLOGY

JAMES A. FARRELL, president of United States Steel Corporation from 1911 until his retirement in 1932, died on March 28, 1943, at his home in New York City at the age of 80. Mr. Farrell was long a member of the Army Ordnance Association and took an active part in its activities. He was a familiar figure at the annual gatherings of the Association held in former years at the Aberdeen Proving Ground. At his death, he was a director of U. S. Steel and was active as chairman of the National Foreign Trade Council which he helped to found in 1914.

Although Mr. Farrell had hoped as a youth to attend Yale University, the death of his father compelled him to seek employment, and he obtained a job with the New Haven Wire Company, Connecticut, and rose to a foremanship in nine years. Seeking better opportunities, he went to Pittsburgh in 1888 and was employed by the Pittsburgh Wire Company, eventually becoming general manager of the mill. After a short period as superintendent of the Oliver Steel Wire Company, Mr. Farrell returned to the Pittsburgh Wire Company, becoming general manager in 1893 at the age of 30.

When the United States Steel Corporation was being organized, Mr. Farrell was assigned to develop foreign sales as president of the subsidiary United States Steel Products Corporation. He became president of the parent corporation in 1911, and during his incumbency production rose from 7,000,000 to 25,000,000 tons and the corporation's assets to $2,500,000,000.

Members of the Ordnance fraternity are indeed grieved by the loss of so staunch a proponent of industrial preparedness.

MAX W. BABB, a director of the Milwaukee Post, Army Ordnance Association, and chairman of the board of the Allis-Chalmers Manufacturing Company, died at his home in Milwaukee, Wis., March 13, 1943. He was a charter member of the Association and one of its most active exponents.

Born at Mount Pleasant, Iowa, on July 28, 1874, he began the practice of law there. In 1904, he was appointed attorney for the Allis-Chalmers Company, later becoming vice-president and general attorney.

In 1928, he joined with other industrial leaders of the Milwaukee area in the establishment of the Milwaukee Post of the Association. The loss of Mr. Babb to the Milwaukee Post and to the national organization is especially great at this time when many of the plans for industrial preparedness which he sponsored are coming to fruition.

NOTICE also has been received of the deaths of the following members of the Association: Allen K. Bucknell, Boston, Mass.; Edward T. Fishwick, Glen Ridge, N. J.; J. W. Fitzgerald, Milwaukee, Wis.; H. R. Goodin, Washington, D. C.; Charles N. Haskins, Lebanon, N. H.; Archibald M. Langford, Hightstown, N. J.; James E. Logan, Washington, D. C.; Thomas O'Donnell, St. Louis, Mo.; J. A. Rieker, Baltimore, Md.; Edward J. Schroeter, Marion, Ohio. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association, extends condolences.

Ordnance in Review

THE MACHINE GUN—THE PERIOD OF RECOGNITION, PART II

LIEUT. COL. CALVIN GODDARD

REVERTING to the Bailey gun briefly described in the preceding installment of this series, search of patent records (for which I am indebted to Mr. Edwin Pugsley, vice-president, Winchester Repeating Arms Company) reveals the fact that its inventor, Fortune L. Bailey, was awarded altogether three U. S. patents for machine-gun mechanisms over the period 1876-1878. These were numbered 173,751 and 173,752 (both dated February 22, 1876) and 206,852 (August 13, 1878).

The first two cover a rather clumsy-appearing gun mounted on the conventional field carriage of the day (Fig. 4) and *belt-fed*. This is the earliest belt-fed machine gun which I have come upon, though the idea of a belt (chain) feed, for hand and shoulder pieces was not new (see "The Treeby Chain Gun," by S. Basil Haw in the March-April 1939 issue of ARMY ORDNANCE, Vol. XIX, No. 113, p. 286). The belt bore a general resemblance only to those of today, though it embodied one feature not too remote from the relatively modern one of disintegrating links. For links it had, after a fashion, in one of the forms described by its inventor, but in the shape of attachable "sections" designed to carry several cartridges, rather than one only, thus (from U. S. Patent 173,751): "The belt may be made in sections and a section of loaded cartridges be hooked or otherwise fastened upon one side whenever a section of the empty shells is removed from the other." And again (from U. S. Patent 173,752): "The belt . . . is made in sections, and each section is fitted with hooks at one end and eyes at the other, or with other easily detached fastenings, so that two or more sections may be readily united . . . as one continuous belt." The material of which the belt was to be constructed is not indicated, but since woven web belting was still so new, it may be assumed that some type of leather was chosen.

Another method of operation involved the use of an endless belt with "loaded cartridges substituted for the empty shells as fast as they pass down from the drum . . ." (Patent 173,751). But since this replacement had to be accomplished manually, we

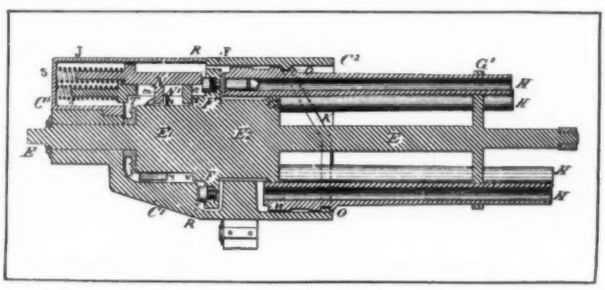


FIG. 3. SECTIONAL DRAWING OF THE BAILEY GUN

observe again that the rate of fire under such conditions could hardly have been phenomenal.

In one of its characteristics, the Bailey gun as originally designed perpetuated a backward feature found in the second Gatling and in Ager's weapon, as improved (see Part II of "The Machine Gun—Its Early Applications" in the November-December 1941 issue of ARMY ORDNANCE, Vol. XXII, No. 129, p. 405). For it provided metal cases into which the cartridges themselves were inserted (distributed equidistantly along the length of the belt) and in which they remained during firing until ready for manual extraction. At the instant of firing, the case holding the cartridge to be discharged was enveloped in the barrel chamber, and to this extent the Bailey mechanism was superior to that of its predecessors. For in those, the individual cartridge container was merely held in line with the axis of the bore, leaving a space at the junction of its forward end with the rear of the barrel (as in the chamber of a revolver) where some leakage of gas was bound to take place.

One of Bailey's first designs (Patent No. 173,752) provided for a separate hammer (pivoted, like that in a rifle or revolver, and actuated by a cam-controlled flat spring) for each of its six barrels. This obviously needless duplication of firing devices was not present in his other patent of the same date (No. 173,751). Here we find two hammers only—rectangular bars reciprocating

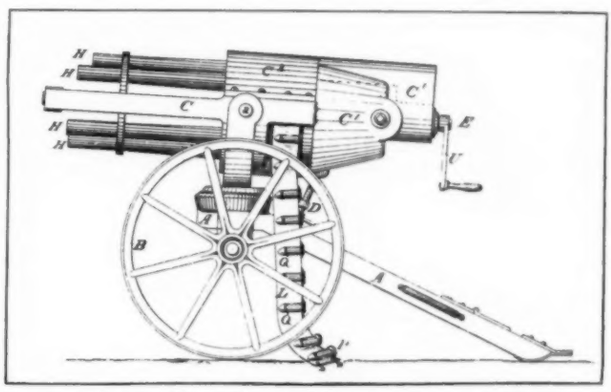


FIG. 4. THE BAILEY MACHINE GUN, 1876

in line with the axis of the firing barrel, and actuated by coiled springs (Fig. 3). These functioned alternately, to impinge in turn upon the single firing pin provided. Each hammer thus discharged every second cartridge. Provision of two hammers rather than one appears to have been based upon the idea that their springs should have a period of "recuperation" following each compression, resulting in longer life and likewise tending to obviate "binding"—at least no other reasons for this strange duplication are apparent.

THE third Bailey patent (No. 206,852, August 13, 1878) covers a lock mechanism only, for a gun with but a single barrel, though the specifications state that "of course, my system could be extended to operate a series of barrels as well as one." Here we find a gravity feed and a hammer-firing pin (one unit) surrounded by a coil spring rather than a firing pin actuated by a separate hammer, as in the earlier type—distinct marks of progress. But operation was slow, as it involved first a partial clockwise, then a similar counterclockwise, manual rotation of the operating handle for each cartridge discharged, firing taking place at the end of the first movement, extraction of the empty case during the second.

No information seems available on the manufacture, sale, or performance in the field of Bailey's weapon. Apparently it was unable to make headway in competition against the manifestly superior Gatling.

Mention having been made above of certain Civil War guns (Ager; first Gatling) discussed in earlier installments of this series, it may be well to introduce at this point additional material bearing upon machine weapons of Civil War vintage which has recently become available. Examination of a copy of "Purchase of Ordnance" (Executive Document No. 99, House of Representatives, Fortieth Congress, 2nd Session, published 1868) reveals the following items on machine guns and ammunition therefor which should be of interest:

On July 8, 1862, 50 "Union repeating guns" were bought from Carr & Avery of New York City for $612.50 each plus an

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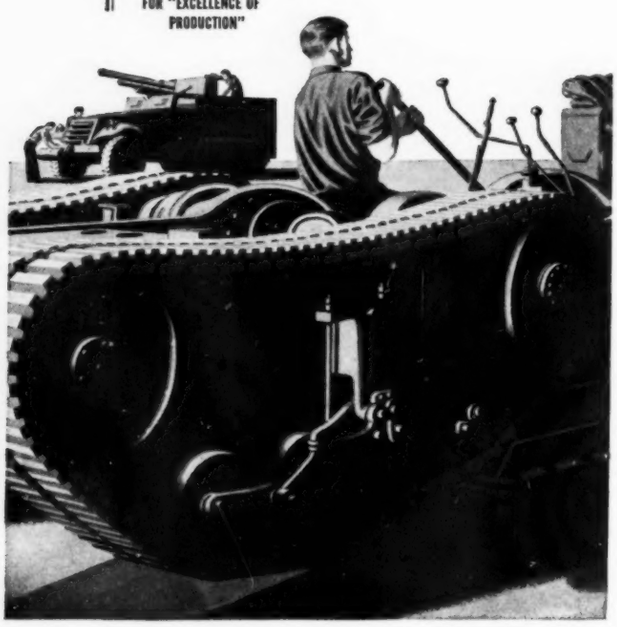
SERVICED BY
FACTORY BRANCHES FROM COAST TO COAST

AWARDED AUGUST 1, 1942
FOR "EXCELLENCE OF PRODUCTION"



Ordnance in Review

additional 20 per cent, by order of President Lincoln. These guns had been contracted for on December 19, 1861. On April 21, 1862, another "Union repeating gun" was purchased. Official correspondence bearing upon the fifty guns purchased on July 8, 1862, appears on pp. 112-113 of the same volume, as follows:

EXECUTIVE MANSION,
Washington, December 12, 1861

My Dear Sir:

I do not intend to order any more of the "coffee-mill" guns unless upon General McClellan's distinctly indicating in writing that he wishes it done, in which case I will very cheerfully do it. This is very plain: He knows whether the guns will be serviceable; I do not. It avails nothing for him to intimate that he has *no objection* to my purchasing them.

Yours truly,

J. D. Mills, Esq. A. LINCOLN.

WILLARD'S HOTEL,
Washington, December 12, 1861

Dear Sir:

The President is under the impression, after seeing the copies of your application to the Secretary of War for fifty guns, and the reply of Colonel Scott, Assistant Secretary, that, as it does not expressly say so, perhaps you do not want them, and that, if you say you want them, in writing, he is ready to order them. He has addressed me a note, of which the foregoing is a copy, for the sake of ascertaining from you in writing the simple fact that you want the guns. Your early reply will give him the desired information, and much oblige

Your obedient servant,

Maj. Gen. George B. McClellan, J. D. MILLS
Commander in Chief, United States Army.

I would recommend that fifty of the "coffee-mill" guns be purchased, at twenty per cent advance on cost price, which cost may be ascertained by competent Ordnance officers. I think $1,200 entirely too high.

GEORGE B. MCCLELLAN
Major General, Commanding

December 19, 1861

Let the fifty guns be ordered on the terms above recommended by General McClellan, and not otherwise.

A. LINCOLN

July 3, 1862

If the fifty guns have been made or tendered according to the above recommendation of General McClellan and conditional order of myself, let them be received and paid for.

A. LINCOLN.

Since the first letter of the above series (Lincoln to Mills, December 12, 1861) refers to an order for *more* of the "'coffee-mill' guns," it would appear that some of these had already been acquired prior to the date of that communication. Careful study, however, of the summaries of purchases listed at the end of the volume (pp. 698-996) fails to disclose any reference to these. One point stands clarified, however. Ager's gun and the "coffee mill" were one and the same. Whether the term was extended to embrace other crank-operated, rapid-fire weapons, we have yet to determine with certainty. (*To be continued.*)

From the Record

THE SIZE OF THE ARMY

WE are planning to have raised by the end of this year 1943 an army of 8,200,000 men composed of 7,500,000 enlisted men and 700,000 officers. This number will include an Air Force of about 2,500,000. It also will include the Women's Army Auxiliary Corps of upward of 150,000.

These figures were not arrived at by guesswork; they were the product of months of study by the General Staff and the War College. They were also the product of joint planning with the Navy over the future work of both these services. The proposed size of the Army, the Navy, the Coast Guard, and the Marine Corps were all determined at the same time, and all these forces were balanced within themselves and against each other, and also in connection with the available man power, the estimated capacity of production of equipment, and the estimated availability of shipping for their transport. These figures have received the approval of the Joint Chiefs of Staff of the Army and the Navy and finally of the President. They have thus had the benefit of all the brains, accumulated research, and judgment which our governmental machinery provides for that purpose. They have not been worked out in disregard of but in full reference to our program of shipbuilding and production of equipment.

When we look at the estimated size of the forces of our enemies which are in the field against us, our numbers certainly do not look relatively too large. I realize that the figures of the hostile forces are estimates only, but they are based upon the best information available to those whose business it is to make such estimates. In Europe, the estimated forces of the Germans and their allies show about 14,000,000 men under arms. Russia and Britain together have a much smaller number. In Asia, the Japanese have more than 3,000,000 men. These figures represent the aggregate of individuals in the various forces.

When we compare the *combat* units of the various forces, the disparity between us is even greater. Our plans are to produce about one hundred American divisions of ground forces, together with their auxiliary troops. Germany is estimated to have approximately 300 divisions, Italy 80 divisions, Germany's European satellites another 80 divisions, and Japan about 86 more. This makes an aggregate of about 546. Making all allowances for error, these figures certainly make our ground forces seem of very modest size in comparison.

It is not the purpose of our military leaders to create a huge defensive army, awaiting in the United States such unknown and uncertain opportunities for its use as may hereafter occur. Their plans are much more wise than that. The Army is being raised on the fundamental and correct theory that we shall at once take the offensive and seize a number of priceless opportunities which are already opening up for us to end the war as quickly as possible.

The training contemplated by this program for the individuals is a process covering a long time. The Germans think two years necessary for such training of their men. We believe that our men can do it in one year, but that is a minimum. Furthermore, the recruits are not all taken into the Army at the same time and all graduated at the same time. Such a method would be impossible for any country, even one as rich and powerful as the United States, and, furthermore, it would not meet the changing requirements of war. It would be too rigid and inflexible. Each of the reception centers and training schools takes in a succession of new classes and these groups are passed along the steps of the course until the final

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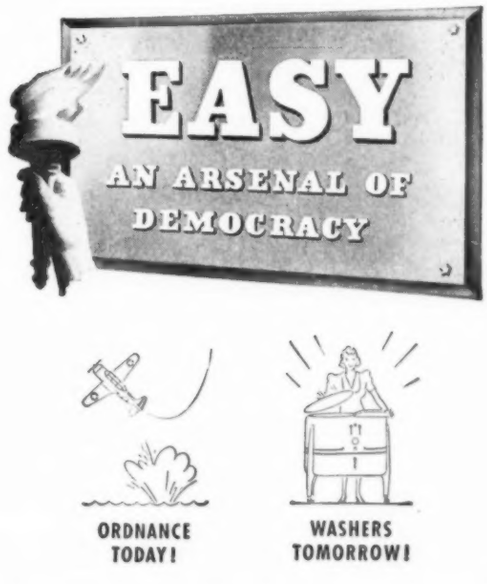
In peacetime we were one of the world's biggest manufacturers of washers and ironers. Today our plant facilities have doubled, our organization has trebled . . . and both are devoted 100% to war production!

Months before Pearl Harbor we began readying for our part in the war. Since then, we have completely equipped our buildings, new and old, with the special tools required to make the war materials assigned to us. We have trained hundreds of new employees, re-trained hundreds of old hands, in the new and exacting duties of their wartime jobs. And we are working around the clock to keep our production moving to you.

In addition, we've put our dollars to work, too! The Treasury "T" Flag, flying above our plant, shows that Easy workers are investing 10% of their salaries in War Bonds every week!

When we tell you this, we don't mean to boast. But we know what you are doing for us . . . and we want you to know that we're trying to deserve it! Easy Washing Machine Corp., Syracuse, N. Y.



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From the Record

product in the shape of army divisions is produced at the end. During each group's training the men are first instructed in the schooling of the individual soldier, are then crystallized into small and later large units for training in coöperative team action in modern warfare, and finally large divisional combat forces emerge from the other end of the system, each highly trained for its specific task.—*Henry L. Stimson, the Secretary of War, in a radio address.*

Fifteen Months after Pearl Harbor—A Balance Sheet of Our War Effort

WHERE do we stand in the war, after fifteen months of fighting? We got off to a bad start. We were surprised at Pearl Harbor—completely surprised—and a heavy blow was dealt to the Navy with great loss of ships and men. The Army lost plenty of airplanes, caught on the ground. It seemed for a time that control of the Pacific might even be lost to the Japanese.

The next blow fell in the Philippines. After heroic resistance against superior forces, we lost the battle of Bataan, and our last foothold vanished when Corregidor fell. We lost our force in the Philippines, some 30,000 officers and men. While it had never been thought that we could hold out there in the event of war with Japan, the loss of this force was undeniably a bad defeat. Meanwhile we had strengthened our posts in Alaska, in Hawaii, and in Panama, and we opened a new route to Australia, a route that was to pay dividends. The first dividend came in May 1942, when we won the Battle of the Coral Sea by the action of Navy and Army airplanes. This was followed by a greater victory near Midway in June. In that engagement, Navy and Army airplanes caught a large Japanese fleet and handled it so roughly that what was left of the fleet tore for home.

In August, the Marines made their landing on Guadalcanal, and after seven months of hard fighting the enemy was expelled from the island. The Japanese lost at least 20,000 men on Guadalcanal. The success of Guadalcanal was due, in large measure, to the fighting done by the Navy in the near-by waters. These naval battles drove off the forces the enemy repeatedly sent down to reënforce their men on Guadalcanal, and the Japanese Navy took heavy punishment. At the same time, the Army, with aircraft and infantry, was carrying on operations on New Guinea along with the Australians. We took Buna and the Japanese positions. The latest operation in that area was the victory of our Air Forces on March 2nd and 3rd in the Bismarck Sea, with the destruction of a Japanese convoy of twenty-two ships.

Our largest operation to date was the North African expedition. We went prepared to fight it out for landings. There was little fighting, the French army coming quickly over to our side. But the Nazis arrived in Tunisia first, and the lines are now drawn there, with the British, French, and Americans facing the Nazis and the Italians. We have the stronger forces, and we will win. In addition to these actions, our Air Forces have been in steady operations against our enemies from bases in the Aleutians, the Solomons, New Guinea, China, India, Egypt, and Great Britain. Their work has been most effective.

As a nation we have learned a number of things from fifteen months of war—a war of varying fortunes. The nation knows that it can count on the fighting spirit of the men in the Army and Navy. We were sure of that before, but there is nothing like the knowledge that comes from performance. The men will outfight the Nazis and the Japanese. They will do it in the arctic or on the equator. We know that the rôle to be played by air power in this war is of vital importance. We were sure of that before the war, too, but the recent record has silenced those who could not see it that way. With scarcely an exception, the victories we have won could not have been won with-

From the Record

out the Air Forces. We know that our weapons are better than the weapons of the Nazis and the Japanese. There was a good deal of debate along that line a year ago, particularly as to airplanes. But the score tells the story—four hostile planes knocked down to one of ours.

WE know, too, that our industrial system can produce the materials of war in quantity; that we can outproduce the Axis powers combined. We are already doing that, and our production has by no means hit its stride. We know that much will depend on our ability to ship men and munitions overseas. The production of munitions is not enough. We must deliver them beyond the oceans, deliver them in mass quantity where their force will be felt by our foes. This means that the submarines must be fought to a standstill, must be destroyed at such a rate that the time will come when the Germans will refuse to go to sea in submarines.

But there is much about the war in the future that we do not know and have no means of forecasting. That there will be surprises—and not all of them in our favor—of that we may be sure. We must be prepared for bad news. It is just as important that we should not allow good news to lead us into the belief that the war is as good as won. George Washington wrote this in the Revolution, and his words are worth repeating today:

"The satisfaction I have in any successes that attend us is always allayed by a fear that it will lull us into security. Supineness and a disposition to flatter ourselves seem to make parts of our national character. When we receive a check, and are not quite undone, we are apt to fancy we have gained a victory; and when we do gain any little advantage, we imagine it decisive and expect the war immediately at an end. The history of the war is a history of false hopes and temporary expedients."

We have it in our power to win this war, but we will not win it without an all-out effort, without a firm resolution to fight it out. We must see to it that the armed forces get the men that they need. The military leaders who know the strength of the forces against us, who plan the operations of the war, who have the responsibility of carrying on the fighting—these leaders know far more about the size of the forces necessary to win than their critics who say that we could win with fewer men. We must see to it that no blanket exemption from military service is given to any entire group, an exemption demoralizing to those that get it as well as to the rest of the nation, an exemption that no other nation at war would even consider. Every deferment should be weighed according to the value to the war effort of the work done by the particular person. In production we must see to it that the need of the fighting men for the equipment with which to fight comes ahead of every other need.

This is truly a total war. We have no choice about it. Our enemies are waging a total war. They are tough and battle-hardened. Their countries are geared to making war. They are clever and ruthless. They are under the control of domineering, brutal leaders to whom human life and human suffering count for nothing. They have driven conquered nations of wretched slaves into their production lines. Enslaved women and children and old men tramp the treadmill of their total war, and their young men are in their fighting land, sea, and air forces, without exception.

We did not want total war or any kind of war. We had no choice about getting into this war. We have no more choice as to the kind of war we must wage. To defeat the enemy, we must support our fighting forces and our allies fully—give them wholehearted, unselfish, complete support. Our fighting forces are our own flesh and blood. Our allies are fighting with us. We will not fail them.—*Robert P. Patterson, the Under Secretary of War, before the Syracuse Chamber of Commerce, Syracuse, N. Y.*

Tanks, tractors, half-tracks, supply trucks and jeeps—the "BENDIX" Drive *starts 'em all!*

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Johnny never will get a medal for shooting down Messerschmitts or Zeros. He doesn't do any shooting. He's just one of the ground crew. But he plays an important part in each fight. #2 men don't get medals. But they're doing a real job.

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Preventive Maintenance

PART III: THE MECHANIC'S RÔLE IN THE FIELD

BRIG. GEN. J. KIRK

IN a nation with over 30,000,000 registered motor vehicles it seems incredible that a sufficient number of skilled, experienced, general automotive mechanics were not available for the rapid expansion of the Army in 1941 and 1942. Many people had assumed that the Selective Service System would be able to supply the necessary personnel, but it did not.

The plain facts are that the Army had to hand-pick men as they came into the service and train them to be drivers and mechanics. The civilian truck driver rarely ever had anything to do with a routine of servicing the unit other than seeing that water, oil, and gasoline were supplied. He had little or no responsibility in keeping the vehicle in operating condition; he depended on his local service station for that. The Army sent him to school not only to learn to be a driver but also to learn the principles of preventive maintenance.

Other men also were selected who, in many cases, had little knowledge of the care and maintenance of motor vehicles. They came from all walks of life. Whenever the selectee showed aptitude for mechanical work or any knowledge of motor-vehicle maintenance, he was hailed as a find. Actually some of the selectees had never even operated an automobile. Still the novices could often be trained more easily than others who had to forget a great deal of misinformation they had acquired. All were given courses of instruction to develop them into general automotive mechanics. The field training program is based on an analysis of the jobs from the standpoint of the echelon, types of automotive equipment worked with, the functions of the units, and the specific jobs. In addition to having had a complete military schooling, the second-echelon automotive mechanics go through a training program which includes among its subjects the following: principles of the internal-combustion engine, cooling and lubricating systems, fuel systems and carburetion, electrical systems, accessory-units service, engine tune-up, engine trouble shooting, chassis, steering and brakes, monthly and semi-annual preventive-maintenance inspections and services, services for vehicles in storage, wrecker operation, half-track, full-track, and other combat vehicles, practical exercises—maintenance of convoys, etc., maintenance of records and reports.

As a result of the intensive training programs, there are thousands of mechanics in the field who have received their training in the Army. Now well schooled, they are engaged in automotive maintenance directed toward a single purpose—keeping the greatest possible vehicle strength ready and available at all times for immediate operations. Maintenance in the field is concerned with the prevention of vehicle failure and with the practice of such trouble shooting and unit replacement as will quickly restore a disabled vehicle to usefulness.

In the first echelon of maintenance, the drivers and assistant drivers use the vehicle tool sets to perform daily and weekly preventive maintenance and to correct minor defects. As a minimum, their functions include servicing, lubrication, tightening, cleaning, care of tools, equipment, tires, battery, and emergency repairs. Each vehicle is supplied with a kit of tools sufficiently complete to take care of this phase of the maintenance.

The second-echelon mechanics are detailed as company, troop or battery mechanics, and battalion or regimental mechanics. Each mechanic is issued a set of hand tools for his own use. Each echelon unit is issued portable unit tool sets, carried on

General Kirk is chief of the Small Arms Branch, Ordnance Department Industrial Division.

trucks. These sets are designed to be used in more extensive preventive maintenance than the driver is required to perform. Company, troop, or battery mechanics are responsible for monthly (1,000-mile) preventive maintenance for wheeled and half-track vehicles or at 50-hour (500-mile) intervals for full-track vehicles and for minor repairs and minor unit replacement within the limitations of their time, tools, supplies, and ability. They use second-echelon tool set No. 1 which is mounted, together with spare parts, on a ¾-ton weapons carrier as shown in the accompanying illustration.

BATTALION or regimental mechanics, or those of detachments or separate companies, provide semiannual (6,000-mile) preventive maintenance for wheeled and half-track vehicles at 100-hour (1,000-mile) intervals for full-track vehicles and 1,000-mile preventive maintenance for motorcycles. In addition, they perform limited unit replacement and are responsible for supply, battlefield recovery, and evacuation. The unit is equipped with second-echelon tool set No. 2, which is mounted on a 2½-ton cargo truck.

TOOL SET NO. 1 MOUNTED ON ¾-TON WEAPONS CARRIER

There are also the higher echelons of automotive maintenance —the third, fourth, and fifth—but as they are not generally concerned with preventive maintenance their functions are not mentioned here. It is not practicable, however, to set hard and fast rules as to what work shall or shall not be done in any echelon. The conditions of warfare change, and officers must have the aptitude and initiative to make the system fit any situation. The scope of each echelon's work is determined largely by both fixed and variable limitations. Dealing only with preventive maintenance, the second echelon is limited solely to its tools, supplies, time, and personnel available to do the jobs.

The monthly (1,000-mile) preventive-maintenance operation, performed by the company, troop, or battery mechanic, is designed to provide lubrication, inspections, and services which will correct any deficiencies likely to interfere with dependable operations during the next month. When a vehicle is assigned permanently to operation by, and under the responsibility of, one driver, the mechanic can take this occasion to call this driver's attention to all indications of faulty preventive maintenance.

While carrying out the monthly (1,000-mile) preventive-

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Preventive Maintenance

maintenance operation, the mechanic is required to note carefully all units of the vehicle needing repair. If he cannot make the necessary repairs within his limitations of time, tools, parts, and equipment, he must report the needed work to his non-commissioned officer who arranges for the transfer to a higher echelon.

The semiannual (6,000-mile) preventive-maintenance operation, performed by the battalion or regimental mechanics, is designed to provide lubrication, inspections, and services which will correct any deficiencies likely to interfere with dependable operation during the following six months. It would be somewhat unusual to encounter a vehicle that had been operated solely by the same driver for a 6-month period, but, if such be the case, this semiannual preventive-maintenance schedule is an opportunity for the mechanic to determine the thoroughness of company preventive maintenance. Improper or inadequate preventive maintenance by the company mechanic or abuse to the vehicle is reported by the battalion or regimental mechanic, through military channels, to the responsible company commander.

During the check-up on the semiannual preventive-maintenance schedule, the mechanic is required to note carefully all units of the vehicle which need repair. If he cannot make the necessary repairs within the limitations of his time, tools, parts, and equipment, he will report the needed work to his motor officer so that the vehicle can be referred to a higher echelon for repair.

Special services which vehicles require when new or because of a change in the season, removal to another climate, excessive water or mud conditions, off-the-road operations, submergence, or other special conditions are performed by the company or similar unit second-echelon mechanics. The second-echelon mechanic should know the peculiarities and weaknesses of each vehicle in his outfit and be able to locate the cause of trouble under any one of the many conditions which may arise.

In mechanized warfare, the recovery and removal of disabled or abandoned vehicles, with the primary objective of restoring the matériel to immediate service is an important function of the second-echelon battlefield-recovery crews. If the second echelon cannot repair the equipment it must then be evacuated to higher echelons by recovery crews of the Ordnance troops.

The Army has furnished units in the field within the continental limits of the United States with experienced civilian personnel. These civilians carry the title of "automotive advisers" and are employees of the Ordnance Department. During the training period, army, corps, division, and separate unit commanders are supplied with these civilian automotive-maintenance experts. They are carefully selected for their past experience and performance records. In many cases they have been maintenance managers for large bus or truck operators, garage superintendents for motor carriers, and foremen or specialists on various types of repair work and parts-inventory control. It is not a part of their duties to make repairs, and they do not give orders. About 1,800 of the civilian automotive advisers are in the field working directly under the supervision of Ordnance officers. Their particular function in military units has been to assist in the training of drivers and mechanics in the principles of preventive maintenance among the first- and second-echelon groups.

The United States will finish this war with the largest and finest equipped land forces in the world. The Ordnance Department proposes to maintain the motorized equipment under its supervision in the highest degree of operating efficiency through the Ordnance school, the Ordnance officers and troops at motor bases, depots, and in the field, and with the aid of its large staff of civilian automotive advisers. But the mechanics are the boys who keep 'em rolling. The mechanic is in the field to insure that the battle will be won by vehicles that can roll. (*Part IV will discuss the field supervision responsibilities of officers.*)

Foreign Weapons

THE BRITISH 6-POUNDER ANTITANK GUN

MAJ. GEN. HENRY ROWAN-ROBINSON, British Army

THE 6-pounder (2.722 kilograms) is now the principal tank and antitank weapon in the British Army. It unfortunately did not arrive, except in insignificant numbers, in time for the Battle of Knightsbridge in the Libyan campaign which preceded the break-through by the British Eighth Army at El Alamein. Its

BRITISH 6-POUNDER IN ACTION AT EL ALAMEIN

absence was a principal cause of the Axis victory on that field. However, from the time the British reached the El Alamein position covering Egypt, it became available in steadily growing numbers until the army of the Middle East was fully equipped with it and was able, partly for that reason, not only to repel Rommel's attacks but also to inflict a crushing defeat on him. It is, therefore, a weapon which, in the short period since its birth, has played a vital and dramatic part in North Africa.

The gun consists of a barrel and breech ring. The barrel is a monobloc steel forging provided with exterior ribs to locate

CRUSADER MARK III TANK FITTED WITH THE 6-POUNDER

it in the "slipper" and with screw threads at the rear end to connect it with the breech ring.

The breech ring consists of a steel rectangular block screwed onto the barrel and contains the semiautomatic breech mecha-

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High Potency Concentrate makes Self-Emulsifying Grease Solvent to remove insulating coats of grease and dirt from truck, jeep, tank, and automobile engines by emulsification and utilizing the heat of a warm engine. Cleaned engines operate more economically since original thermal efficiency is restored. (Data Sheet #96)

Unique Oil removes salt; may be applied to metal surfaces wet with sea water. Cleans, dehydrates and leaves thin film of rust-preventive compound. Suitable as a cleaner-preservative and lubricant for small-arms bore cleaning. (Data Sheet #97)

High Boiling Dehydrating Oil absorbs residual water from parts, storage tanks or equipment. Recovery for repeated use made by simple heating above 212° F. (Data Sheet #98)

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Instrument Shampoo emulsifying solvent cleans optical lens and delicate mechanisms without harmful effect. Results in physically clean work and complete absence of any film. (Data Sheet #103)

Fluid, Pre-Paint Cleaning extracts and emulsifies all traces of wax, oil, and grease from hard surfaces. Rinses with water . . . leaves no film. (Data Sheet #104)

Non-Caustic Emulsion cleans brass and steel shell cases. Solution may be handled safely by women. Cold or hot solutions are effective. (Data Sheet #105)

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FOR FURTHER INFORMATION

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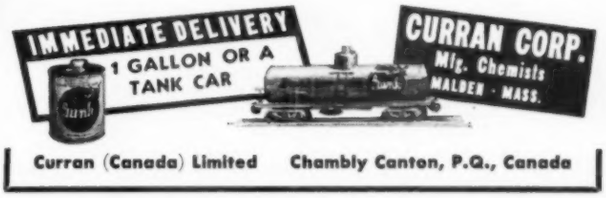

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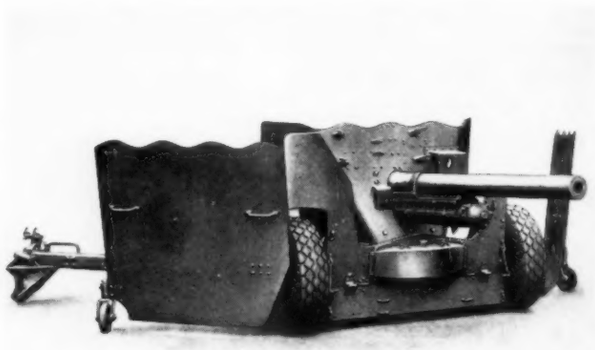
Foreign Weapons

Firing the 6-Pounder from Its Motor Carrier

nism. The action of opening the breech, by operating the breech mechanism lever, lowers the sliding block and compresses the spring housed in the spring casing on the right of the breech ring. The movement of the block at the same time causes the extractor to pivot backward, ejecting the spent case and, by engaging lugs on the breechblock, locks the block in the open position against the pressure of the spring. This movement also recocks the firing mechanism. When a fresh round is loaded, the lip on its base carries the extractors forward and disengages them from the lug on the block, thus freeing the latter and allowing it to be returned to the closed position by the action of the spring.

In action, the trails of the carriage are thrown outward and thus give the necessary clearance for all angles of elevation and traverse for which the carriage is designed. At the same time, with the spades engaged, they afford, together with the wheels,



The Gun Crew Is Protected by Movable Side Shields

a firm support to the superstructure and a check to the recoil of the carriage. The recoil system consists of a hydraulic buffer of the usual type and a spring recuperator, both carried close under the gun inside the cradle.

There are four shields. The upper front shield is attached to the saddle and traverses with it. The lower shield and the two side shields are attached to the axletree and move only when the whole carriage is shifted. To facilitate this movement, the side shields are provided with small wheels at their outer ends.

As an antitank gun, the 6-pounder normally is either carried in a lorry or towed by one. In an emergency, or when acting as escort to a convoy, it can be fired from the lorry if necessary. The weapon is effective up to 800 yards (731 meters) while it cannot fail to destroy a tank at 200 yards.

Professional Digest

THE ARMY CONSERVES ITS TIRES

CAPT. B. W. WOOD

TODAY, personnel by the thousands, throughout our Army's Ground and Air Forces are assigned solely to the duty of caring for tires in everyday use or in storage. Every commander is made responsible for maintaining and conserving the rubber in his organization. When a unit has to move, as most do, with automotive equipment, woe to the commanding officer who has failed to enforce the regulations governing the protection of the tires on his vehicles! Largest single user of tires in the world, the Army has made every one of its personnel keenly rubber-conscious through its program of prevention of abuse and excessive wear and of repair and conditioning of tires.

Conservation of rubber has been practiced in the Army since World War I, when horse-drawn vehicles were replaced by motorized equipment. Not only had the Army been practicing maintenance of its tires for many years before a rubber shortage developed, but, almost as if the occasion had been timed with an uncanny accuracy, a text entitled "Army Motor Maintenance, Text No. 23, Care and Maintenance of Pneumatic Tires—Casings, Tubes, Valves, and Rims," was released *December 1, 1941*, just six days before Pearl Harbor. That document, in turn, became a technical manual known as TM 31-200, on the care and maintenance of pneumatic tires.

But the Army didn't merely print instructions on how to care for the tires. A possible shortage in our rubber supplies had been anticipated, and commanders ordered stricter inspection, a more rigid operation of the preventive-maintenance procedures, and extra efforts to conserve rubber by rebuilding or conditioning any tire which could still be saved. Even then, every scrap of usable rubber was salvaged by the Army.

The Ordnance Department today is conducting schools for both commissioned and enlisted personnel detailed to motor transportation—from generals down to drivers and mechanics—to teach that preventive maintenance "keeps 'em rolling." Schools, manuals, lectures, and demonstrations have been employed for months to teach the Army's personnel that "an ounce of prevention is worth a pound of cure."

THE Army training program has evolved a few simple principles that must be applied every day in the preventive maintenance of tires. Whether military motor vehicles, interstate bus lines, motor truck carriers, or Mr. Average Citizen's car are concerned, the same rules can be applied.

In studying causes of tire failure, underinflation has been determined by the Army as *the major avoidable abuse* in causing tire failures. What causes underinflation?—carelessness in not inflating regularly and accurately—carelessness in not detecting slow-leaking punctures and missing valve caps—carelessness in *not doing something about it*. Preventive maintenance in the Army requires inflating the tires regularly, as they need it, once a week or once a day, depending on the service; correcting leaks which would lead to underinflation; and detecting and repairing casing damages in their early stages which, if neglected, would result in ruined tires.

Another reason for tire failure is overinflation. The excessively overinflated tire has a smaller-than-normal tread area contacting the road. The load is carried by the center ribs of the tire alone instead of being shared equally by the center ribs and the outer edges, or shoulders. The result is that overinflation causes the center of the tire to wear very rapidly. As much as fifty per cent of the life of a tire can be lost by overinflation. When operating over unimproved roadways, a break

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may be caused when an overinflated tire strikes a rock or hole.

Another prevalent faulty condition is misalignment of wheels. Frequent inspections are made in the Army to examine tire treads for symptoms of uneven wear, such as cupping, wearing off on only one side, or wearing with a feather edge. Any one or all of these tire conditions may mean improper alignment. Despite corrective efforts, however, as required in preventive maintenance, tires simply do wear irregularly. This is a state of normal wear and tear. The rate and degree of wear depends largely upon terrain, speed, and load.

Unless tires with uneven wear are rearranged on the vehicle

Tire Casing after Being Driven While Flat

in relation to the wheels, they will wear out in spots. Such rotation of tire position will tend to even up irregularities in wear. Front-wheel and trailer-wheel tires with irregular wear should be changed to driving wheels. The regular practice of rotating the tires around a vehicle whenever uneven wear appears, or every few months, will help to get the mileage out of the tires that was built into them. Since the spare is included in this method of rotation, it is easy to see that the full life of each tire will be realized before new rubber must be expended on the vehicle. Furthermore, tires stored or carried as spares deteriorate more rapidly from exposure to sunlight and other elements than tires in use on wheels. Spare tires not employed in a rotation plan should nevertheless be interchanged with tires on the wheels at intervals not to exceed ninety days.

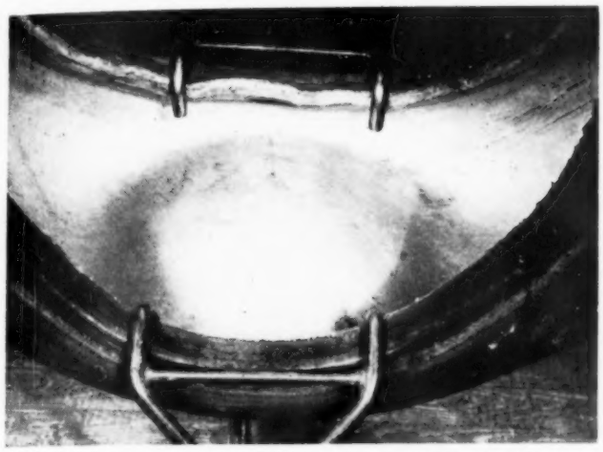
The Army requires tires with directional mud and snow treads to be mounted on front wheels (driving or nondriving) and on trailer wheels so that the point of the chevron "V" touches the ground last. This saves wear. The only exception to this rule is made in the case of combat vehicles, like scout cars and half-tracks, where full traction is the first consideration. Directional tires should be mounted on all rear wheels so that the point of the "V" touches the ground first.

Quick or jerky starting, sudden stopping, and failure to slow down when turning curves, all grind off tread rubber. Carelessness in avoiding obstructions such as loose objects and holes or ruts increases tire injuries. Running on flat tires even a few feet, or on almost-flat tires for some distance, will ruin the tube and carcass. Overloading tires, or distributing loads unequally will bring on tire failures. Improper application of chains or failure to remove chains when no longer necessary may gouge or cut the tread and sidewalls of tires. Operating military vehicles with the front axles engaged, except when the added traction is necessary, is a senseless waste. This practice can cause serious premature wear of rubber.

One of the tests conducted by the Army demonstrated conclusively what can be done in the *right way* to conserve tires.

Professional Digest

The test run was made over 14,000 miles of every kind of terrain —sand, cobblestones, smooth highways—and through mud, snow, rain, sleet, heat, and cold. Fourteen 2½-ton trucks went out on the tire-testing convoy. Each truck was equipped with 7.50-20 tires of different designs, and each traveled under a full 5,000-pound load. For the first 500 miles, the speed was 30 miles an hour; thereafter, 35 miles an hour. At 500-mile intervals throughout the trip, the tires were changed from truck to truck—the wheel position of the tires being left unchanged. Right front tires were always kept on right front wheels, for example. Changing the wheel positions of vehicles acts in the same way



THE SAME CASING AFTER REPAIR AT THE ORDNANCE SCHOOL

as rotating tires on one vehicle. In the cool of the morning, the pressure of each tire was brought accurately to 55 pounds. Valve caps were securely tightened.

Throughout the trip, the loss of tread and rubber was carefully checked with depth gages and scales. At the end of 9,000 miles, the average loss of tread on the 5 best tires in the fleet was 9.4 per cent, and the average loss of rubber was 2.02 pounds. After 14,000 miles, the average tread loss was 18.9 per cent, and the average loss of rubber was 3.2 pounds. Based on these figures, the tread design which had the most wear had a potential life of 40,000 usable miles. This shows what is possible under the most favorable conditions.

THE Army's second phase of tire maintenance is conservation. A comparatively new organization has been activated in the Ordnance Department—the "tire company," created in 1942—and such units are serving in foreign fields as well as at Ordnance bases and in the field at home. After a tire has been worn to a point where continued use is unwise and unsafe, or a break or blowout requires repair, it becomes the duty of the tire company to repair or rebuild the tire casualty so it can be put back into service as soon as possible. The company does not handle minor repairs to tires that can be taken care of in forward echelons of maintenance. When a tire reaches the company, real tire surgery is necessary, or else the salvage unit is called in, but every effort is being made by Ordnance units to save any tire from being turned over to salvage.

At the Holabird Ordnance Depot, old methods of tire repair are being improved and new ideas are being worked out to accomplish what has never been done before in tire surgery—difficult and unheard-of tire repairing and recapping. From that depot and from other Ordnance centers, enlisted men and officers are being sent out after eight weeks of intensive training at the tire schools to form new Ordnance tire units such as the tire companies. Every officer and enlisted man who completes a course at a tire school has been taught that efficient operation

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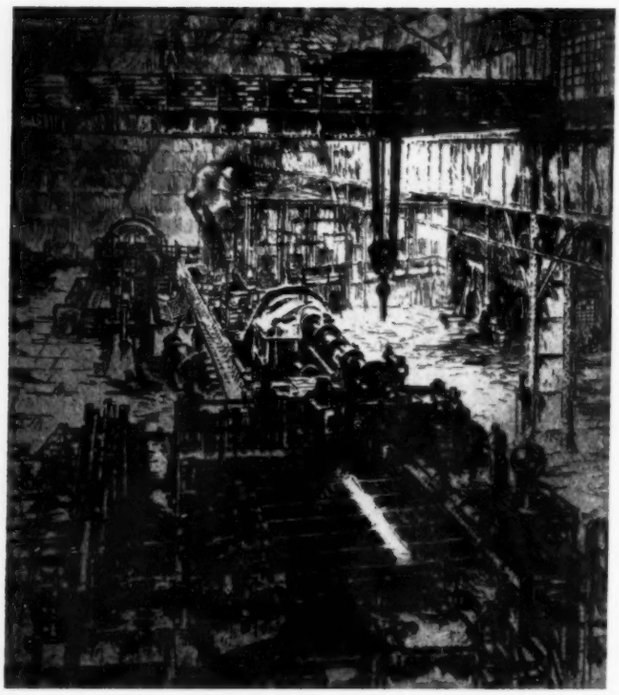

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Professional Digest

of tire companies lies in saving ninety-nine per cent of the tires from the salvage units and doing it so the repaired or recapped tires can be counted on to furnish further service equivalent to an average of ninety per cent of the tires' original lives.

Combat tires are vital articles on critically important vehicles in a zone of combat, and their care and maintenance is an acute matter. Every combat tire must be kept in serviceable condition as long as possible. In repairing or recapping combat tires, the Army sought the help of civilian firms on curing the rubber. Their assistance has been valuable, and their efforts, combined with study by Army technicians, have apparently solved the problem. Thus, tires can be put back in service in the field without scrapping large amounts of valuable rubber and calling on the rear echelons for new equipment. This new curing method is being imparted to the field tire companies.

Unusually large cuts, breaks, or tears, so large as to cause the scrapping of a tire under old standards, are being repaired. One repair on exhibit covered a large destroyed area in an 8.25-20 casing. A perfect repair job was done on this tire at the Holabird school, enabling it to be used again in limited service. Another tire, 10.00-22, 12-ply, had a hole large enough for a man's fist to pass through, and it also had many machine-gun bullet holes in the carcass. When the officers' class at Holabird finished with this job, the tire was put in service again. That tire, when inflated to 70 pounds' pressure, must support a gun and carriage weighing 4,400 pounds on each wheel. An 8.25-20 new tire had been driven while flat. It was ruined according to accepted standards—the cords were broken and hanging loose. A method tried out in the tire school made the tire again usable.

Before the Senate Agriculture Subcommittee, January 26, 1943, Donald M. Nelson, War Production Board chairman, in answering a question by Senator Wheeler of Montana, was quoted by the Associated Press as saying: "A low point in the rubber supply will be reached next November and December." His words were buried in a 2-column dispatch covering a number of subjects. No emphasis was placed on this important prediction by a high Government official who certainly should know what to expect in the future. Much has been stated and written by various authorities on the rubber shortage, but Mr. Nelson has issued a warning that between now and next December a low point in the rubber stock pile will be reached. Too late we may find there is not enough.

The "Bazooka," Latest Ordnance Weapon

THE new weapon known as the "bazooka" discussed by General Campbell in his article on page 493 of this issue is revolutionary in design. It can be carted about in a jeep or a peep or can be carried by two men at a dogtrot. It hurls a high-explosive projectile. The "bazooka," the product of long experiment by the Ordnance Department, is now standard equipment for certain classes of troops. Primarily it is for use at relatively close range, and it supplements rather than supersedes other weapons. It is designed to be operated by soldiers who work in teams, one to load, the other to aim and fire.

Tactics have been developed for use of the new weapon in both offensive and defensive action. Raiding groups, tank-hunting parties, and reconnaissance elements are expected to find it highly effective; also landing forces which may encounter pillbox or mechanized defenses. In defensive action, the operators of the "bazooka" will be recruited from among chauffeurs, truck drivers, ammunition bearers, orderlies, clerks, and mess personnel so that other arms may be free to use their ordinary weapons and thus assure maximum firepower. All men in the service, however, will be schooled in the care and use of the new weapon.

In addition to penetrating steel armor, the projectile will drive

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through brick walls and rock masonry with a powerful blast effect. It will shatter cast steels and such material as bridge girders and railroad rails, and perform other seeming miracles. Before very long the "bazooka" will be heard from on all the fronts.

Smokeless Powder from Wood Pulp

THE adaptation of wood pulp for powder manufacture by the Hercules Powder Company has increased powder output about one-quarter wherever it has been used and has freed Canada and Australia from dependence upon cotton. Development of the new powder process is credited to Ralph L. Stern, chemical superintendent at the Parlin plant of the company, whose experimental work on wood cellulose made possible the use of wood pulp for rifle and cannon powders. The Hercules Company made available the wood-pulp development without cost to the governments of United Nations and to all American producers as soon as it had been found effective.

Powder usually is made from cotton. Previous attempts to use wood pulp had resulted in powder of uncertain quality and the process was slow and expensive. When the War and Navy Departments' requirements for smokeless powder were presented, it became apparent that supplies of cotton would be entirely inadequate for the war program.

Therefore, to facilitate ease of manufacture and hold costs down, a process was sought which could utilize the commercial grades of wood pulp, such as those used in rayon manufacture, which were then being produced by existing wood-pulp plants. For this purpose it was imperative also that the wood pulp should function in nitrocellulose plants designed for the manufacture of nitrocellulose from cotton. By accomplishing this, no alterations in the plant process were required and special plant construction was eliminated.

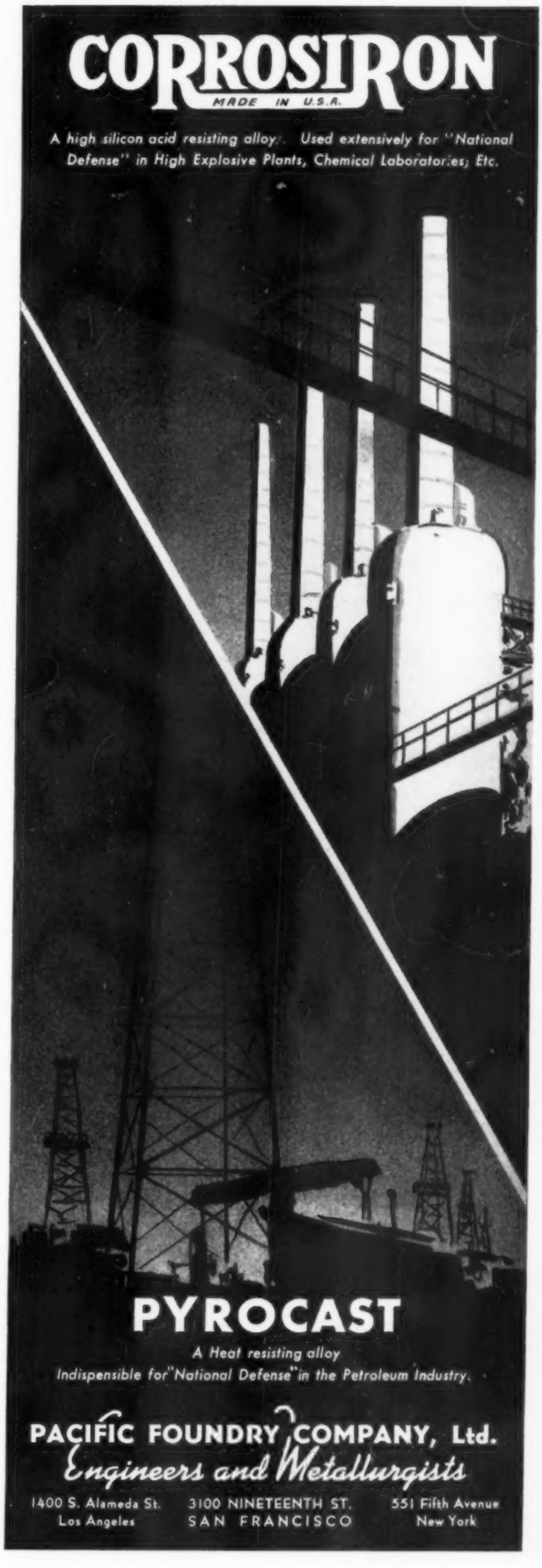
The Weyerhaeuser Timber Company of Longview, Wash., and Rayonier, Inc., of San Francisco, Calif., coöperated in the experimental work, supplying wood pulp in the form and according to the specifications required for the smokeless-powder process.

It is estimated that the wood-pulp development, based upon the difference in the cost of the cotton and wood pulp, will lower the cost of manufacture of smokeless powder at United States Ordnance plants about $20,000,000 in 1943.

Steel Cartridge Cases for Caliber .45 Ammunition

A NEW manufacturing process now makes possible the substitution of steel for brass cases in caliber .45 ammunition. The process, perfected by the Evansville Ordnance Plant working in conjunction with Frankford Arsenal, advances the Army's program for conservation of critical materials another step. A change-over from brass to steel for all types of fixed and semi-fixed artillery ammunition was completed the first of this year. The saving in brass by the new process amounts to 1,774 pounds for each 100,000 rounds of ammunition. The new cartridges with steel cases have been tested and accepted by the using services. Large-scale production is already under way, and all plants making caliber .45 ammunition will adopt the steel cartridge case.

Eight months ago, the Evansville plant was close to a shutdown because of the acute brass shortage. Brass, which expands with the explosion of the powder charge and then contracts, permitting the extraction of the cartridge, had been universally used. The successful institution of steel, removing a serious limitation on ammunition production, was accomplished in six months. In the same period the Frankford Arsenal perfected a steel copper-plated jacket for the caliber .45 bullet which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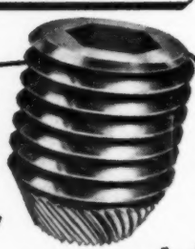
Knurling of Socket Screws originated with "UNBRAKO" years ago.



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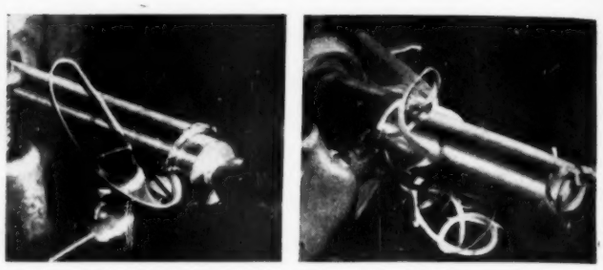
resulted in a saving of 780 pounds of gilding metal (90 per cent copper and 10 per cent zinc) for each 100,000 rounds.

Free-Machining Invar Low-Expansion Alloy

THE use of a thirty-six per cent nickel alloy known as Invar has long been limited by machining difficulties. This problem now has been overcome by the Carpenter Steel Company, Reading, Pa., with the development of a free-machining grade of Invar now in commercial production. For some time, Invar in various forms has been used in applications where it was necessary to overcome the natural tendency of metals to expand when heated. By providing a rate of thermal expansion approximately one-tenth that of carbon steel at temperatures up to 400 degrees Fahrenheit, this alloy is contributing to the accurate operation of radio and electronic devices, thermostats, etc.

Whereas regular Invar bar stock is extremely difficult to machine, the new type is claimed to machine easily, at a saving of as much as seventy-two per cent in machining time. The addition of selenium to the alloy gives it the free-cutting properties yet does not alter the metal's low thermal-expansion characteristics. Any one familiar with the difficult machining properties of 18-8 stainless steel before the free-machining type came into use will have an idea of the difficulties involved in machining the regular-type Invar bar stock. Actually, straight 18-8 is easier to machine than regular Invar, although this stainless work hardens while Invar does not.



Relative Machinability Test

Left: Rough turning a bar of regular Invar. *Right:* The same operation on free-machining Invar.

Safety Tractor for Use in Hazardous Locations

AN explosion-tested, battery-operated tractor unit for material handling recently has been developed by the Mercury Manufacturing Company in coöperation with the Westinghouse Electric & Manufacturing Company. The tractor is used for hauling trailers within such places as shell-loading plants, Ordnance depots, refineries, munitions plants and other vital war industries where hazardous locations require the ultimate in safety regulations.

Explosion-tested equipment is designed and built to prevent explosions caused by igniting an explosive atmosphere with the arcing present with all electrical equipment that has moving parts. Rigid specifications have been set by the Bureau of Mines and Underwriters Laboratories for electrical equipment used in hazardous locations, such as gaseous mines, where the normal arcing of electrical apparatus would ignite the surrounding atmosphere. To conform to these requirements, the equipment is totally enclosed with very close tolerances on all parts that extend through the wall, such as motor and controller shafts. Any flame from inside the compartment is extinguished before it can do any harm on the outside. All fits are metal to metal; no gaskets are used. The electrical compartments must be capable of withstanding pressures caused by any internal explosions of a mixture of methane gas without damage to the motor

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and control and without transmitting any flame to the outside.

A straight-series direct-current motor is best suited for traction applications of this kind. This motor develops its highest torque at low speeds and, as it is better adapted for variable speed, it provides more maneuverability. This particular motor has a continuous rating of 30 volts, 80 amperes at 2,000 r.p.m. and is capable of withstanding a 100 per cent overload for one hour. Since it must be totally enclosed, provision must be made for periodic inspection and routine maintenance. Accordingly, a commutator-end housing with provision for inspection holes was applied. Screw-type covers are used which offer a ready means of access to the inside of the commutator end of the motor and at the same time conform to the Bureau of Mines requirements for a tight seal around these openings. Both the commutator and

SAFETY TRACTOR HAULING A LOAD OF SHELLS

pinion-end housings are equipped with a special construction that provides a long flame path to extinguish any flame caused by an internal explosion.

While the motor is considered as an individual unit, the control presents an entirely different problem. Unlike a conveyor belt or other industrial application, traction equipment must provide variable speeds to variable torque. To simplify the control arrangement and still meet the Bureau of Mines total enclosure requirements, all the control apparatus is housed in a single welded steel box that is explosion-tested. This permits the box to form a part of the tractor and provides convenient space for the operator's seat within easy reach of the controller.

THE NEW TRENCH KNIFE, M3

A NEW type trench knife, superseding the previous standard model which has been issued by the thousands to combat troops in this war, is now under procurement by the Ordnance Department. The new knife, officially designated as "Knife, Trench, M3," is a sturdy, sharp-bladed weapon suitable for hand-to-hand fighting and various other field uses. In appearance, it resembles an oversize hunting knife.

The knife has a comfortable, corrugated rawhide handle with a 6¼-inch blade. One cutting edge runs the full length of the blade; the other cutting edge extends for 2¾ inches. From that point to the hilt, the steel widens, providing extra strength.

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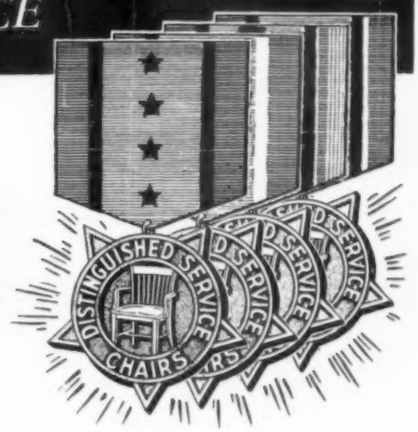

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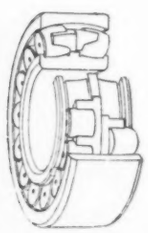


SKF

BALL & ROLLER BEARINGS

Professional Digest

A new sheath has been designed especially for the new knife. Made of rugged leather, the sheath can be attached to general-issue web belts or to trousers belts. There are metal plates on both sides of the sheath to protect the wearer from injury in a fall, for example, wherein the knife blade might otherwise pierce the sheath. The knife is secured in the sheath by a band and clasp. Redesign of the Army's trench knife has been conducted largely to conserve critical materials. The former standard trench knife, M1, has a grip and studded hand guard of cast bronze, a metal eliminated from the new M3, resulting in quantity savings of bronze.

The Trench Knife, M3

Quantity issue of the new trench knife to U. S. combat troops is now under way.

Other Recent Developments

AFTER nearly a year of severe tests, the Sikorsky helicopter has been adopted by the Army and more are to be built for service testing under field conditions. The first model for the Air Forces was manufactured by Vought-Sikorsky after many years of development and experimentation by civilian engineers of the manufacturer and by engineers of the Air Forces Matériel Center. The new aircraft has no wings; it is raised from the ground by horizontal lifting propellers rotating above the fuselage. These may be tilted slightly in any direction, thus giving horizontal motion to the craft. It also has a small vertical tail rotor with variable-pitch blades which serves to correct the main rotor torque. Not only can the craft rise or descend vertically, but it can hover motionless in the air at any altitude and can fly forward, sideways, or backward. The helicopter has particular value in liaison: It can land or take off from an area twenty feet square and hence may operate from the decks of warships or other confined locations.

The Army has been experimenting with 30-foot truck trailers designed to haul troops to danger zones ready for combat. The vehicle is entirely open and consists of three platforms pyramided in step formation on the trailer body providing seats for 206 men. The men ride facing outward and hence the trailer may be unloaded and the men fanned out over a 50-foot circle in less than ten seconds, offering a difficult target to strafing airplanes.

The Japanese Grenade Thrower

THE Japanese grenade thrower is not a "knee mortar" as has been erroneously reported from time to time, although it may be fired by a man in the kneeling position or its base plate may be held down by the knee, but the plate must be on the ground or other solid support when firing. As the *Infantry Journal* points out, it cannot be fired from the knee without risk of serious injury and was never intended to be fired from that position. Not only is the firer likely to have his leg broken by such tactics, but the line-of-sight mark is turned away from the operator. Moreover, the curve of the base plate is too sharp to fit the leg of a normal man. It is not meant to be carried strapped to the leg either, as its weight and size would make the wearer's progress quite difficult.

Book Reviews

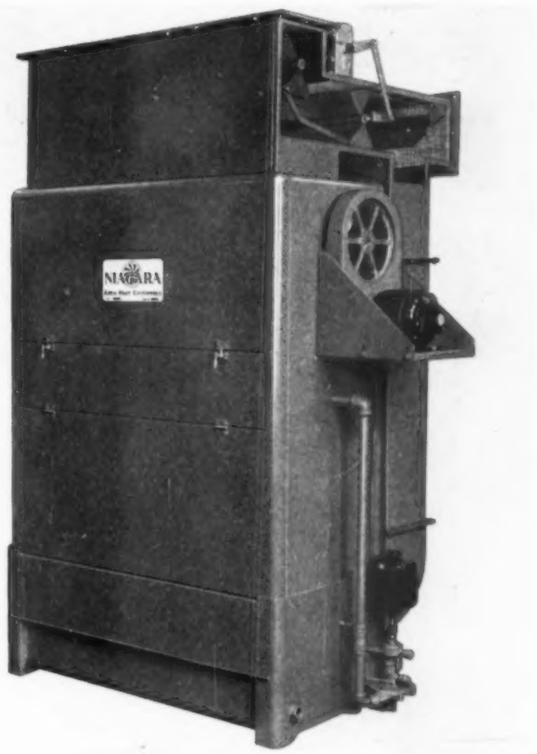
A COMPREHENSIVE SMALL ARMS MANUAL. By Charles T. Haven. New York: William Morrow & Company. 159 pp. $1.50.

MR. HAVEN, whose recent significant contributions to the literature on small arms and ammunition should make him no stranger to most devotees of the "leveled tube," has now produced a handy little volume for "state guards, regular police departments, Coast Guard auxiliaries, plant guards, auxiliary police departments, civilians," his idea being to familiarize members of these groups with certain basic characteristics of the weapons and ammunition likely to be placed in their hands during these uncertain times. The book, the title of which may unfortunately cause it to be confused with Barlow's "Small Arms Manual" (London, 1942), is divided into ten chapters and a bibliography and discusses in turn military-type rifles, sporting rifles, shotguns, submachine guns, pistols and revolvers, ammunition, knives, and rough and tumble. In addition, there are introductory and concluding chapters on "Problems and Possibilities," "General Instruction," and "General Firearms Tactics."

Considering the brevity of the work, Mr. Haven appears to have covered his subject with reasonable thoroughness. Indeed, he is perhaps too thorough when he includes descriptions of arms the ammunition for which is at present practically nonexistent in the United States (*e.g.*, the 11-mm. Mauser and .577/450 Martini-Henry). At the same time he makes no mention (save inferentially, by naming certain cartridges used in them) of any of the lever-action rifles so generally available today, with the exception of the '95 model Winchester and the '99 Savage. We find nothing on the lever-action Stevens rifle handling the distinctly modern range of Remington autoloading cartridges in calibers .25, .30, .32, and .35, nor on the '86 Winchester with its .33 W.C.F. cartridge and other powerful loads, or the '94 in calibers .30-30 and .32 W.S., and Marlin lever-action models for the same cartridges. In like manner, some of the older varieties of Colt and Smith & Wesson revolvers are either ignored (Colt "Lightning" model) or dismissed with a word (Smith & Wesson "Russian" model); whereas the absorption of more modern types by first-line guards and police agencies leaves organizations with lower priority ratings to accept these earlier, and still thoroughly effective, designs or to do without.

In his discussion of ammunition, Mr. Haven similarly damns with faint praise the .38 short and long Colt cartridges in comparison with the .38 Special. This would be quite to the point were the last-named everywhere available—which it decidedly isn't. And the .38 long Colt, for some 20 years (1892-1911) the standard side-arm load of the U. S. Army, is by no means to be despised—even if that Army did undertake to destroy, shortly before the outbreak of the present war, considerable stores of this for which home guards today would be happy to give their eyeteeth.

Mr. Haven's constant stress upon the observance of safety measures in the employment of firearms is distinctly commendable. The illustrations and tables scattered through his volume are interesting and helpful. But he fails to note, in his discussions of shotguns and ammunition for these, that the United States Army, evidently classifying its human adversaries as "migratory game," issues, under the provisions of the Migratory Game Act, with all repeating shotguns distributed to troops "a hardwood plug . . . for insertion in the end of the magazine to reduce its capacity to two shells" (Section 3, TM9-285, p. 7, War Department Technical Manual, "Shotguns, All Types," September 21, 1942)!



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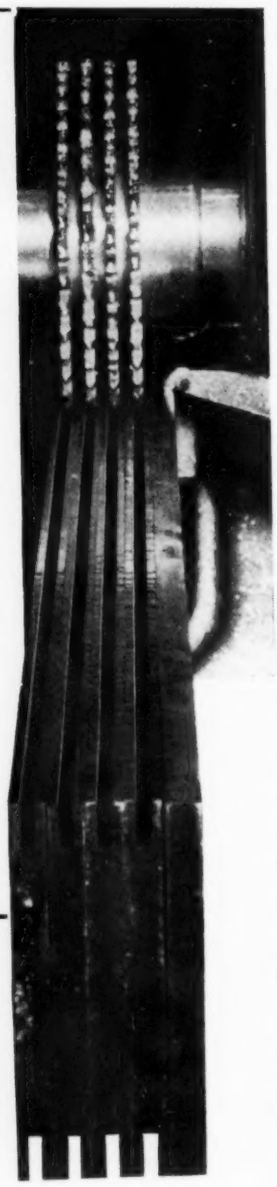

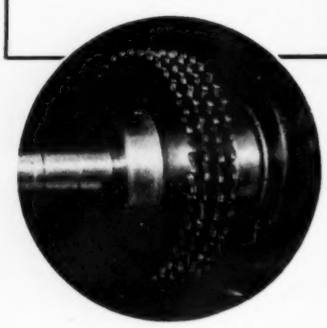

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Book Reviews

Numerous typographical errors, the most serious being the adornment of Georg Luger's name with umlaut (Lüger) wherever it appears, have escaped the proofreader. Apart from these, and from the author's tendency, already noted, to describe the best and latest in arms and ammunition—which generally can't be had—rather than to devote greater space to more readily available models of earlier vintage, the volume is distinctly commendable. The inclusion, in the brief bibliography with which it ends, of "The Gun Book" by McKee (New York, 1918) is a stroke of genius, for in that little volume may be found, in words intelligible to any literate soul, the alpha and omega of the rifled weapon. N. D.

BATTLE FOR THE SOLOMONS. By Ira Wolfert. 200 pp. $2. Boston: Houghton Mifflin Company.

GUADALCANAL and the battles of the Southwest Pacific are pictured in vivid writing with all their jungles, swamps, mountains, and heat—Marines against odds never less than two to one and more often ten to one. The writer, from a grandstand seat where he was subjected to most of the dangers, gives an eyewitness account of warfare with the rule book thrown out the window. The encounter between a lone destroyer and a Japanese battleship reads like fiction. The author's apt phrasing, clever similies, and easy writing make this the finest factual account yet received. It answers lots of questions, such as why the Japanese do not surrender. It shows the Japanese to have the world beaten for plain "guts," but as a fighting man he is not up to our Marines and sailors. The reader is left wondering if we are not trusting too much to luck and the endurance and fighting qualities of a few men when so much is at stake and help is so necessary. This book should be in every military man's library. T. K. V.

SILENT ENEMIES. By Justine Hill. New York: G. P. Putnam's Sons. 266 pp. $2.50.

MISS HILL has produced a timely volume on the unseen enemies which American military forces must combat, and combat successfully, if they are to prevail against the more tangible weapons of the Axis powers. It is common knowledge that, until within recent years, disease has taken a much heavier toll among fighting men than have enemy projectiles. But today, as Miss Hill shows, disease has been relegated to a secondary position, and means to combat its ravages are being developed so rapidly and so extensively that the modern soldier has no occasion to look upon it with the mingled fear and awe which possessed his forebears of past centuries when whole armies were decimated by disease.

Particularly is this true of the infections which routinely invaded battlefield injuries. The introduction of sulfa drugs has happily rendered the majority of these all but impotent. Even the organisms which formerly caused fearful periodic epidemics are now largely under control. Malaria, yellow fever, typhus, plague, cholera, influenza, typhoid, dysentery, and other lesser scourges are fighting losing battles against the sanitary services of modern armies. Shock from wounds and burns, formerly a prime cause of fatalities in the field, is successfully combatted by plasma transfusions. Venereal diseases, erstwhile responsible for consistently high noneffective rates among the military, are giving way before arsenic and sulphur compounds. Even such lesser entities as mumps and measles face eradication under the attacks of modern medicine.

Miss Hill has presented in an extremely readable style an analysis of the medicomilitary picture of today's World War. No one can peruse her volume without feeling a sense of pride in the achievements of the disciples of Aesculapius and confidence in the ultimate outcome of their struggle against man's "silent enemies." C. G.

Book Reviews

How COLLECTIVE BARGAINING WORKS. By Harry A. Mills. New York: The Twentieth Century Fund. 1,000 pp. $3.

A SURVEY of experience in leading American industries, this book is filled with a wealth of knowledge, up-to-date facts, opinions, and trends. "Collective bargaining is now written into the law of our land. All political parties endorse it, most industries have it. Here is a dynamic force that profoundly affects the conduct of American business and the lives and earnings of millions of workers."

This survey has been assembled by that able research director, Harry A. Mills, supported by a committee eminent in the field of arbitration and the settling of disputes, and sixteen contributing authors, all well known for their research and analytical ability in this field of endeavor. This group studied sixteen industries and here briefly review the history of labor-management relations and examine in a concrete, down-to-earth manner the main practices of today. All kinds of industries are included: newly organized and sometimes turbulent ones, such as steel, rubber, automobile; well-established industries, such as railroads; highly intricate ones, such as glass.

Any one directly concerned with any phase of collective bargaining as employer or worker, as representative of management or union, as student or teacher, as a public official, or simply as a citizen interested in one of the central problems of American democracy, will be richly rewarded for his perusal of this survey.

Some knotty problems discussed herein are the open or closed shop, the check-off, industrial versus craft organization, "maintenance of membership" clauses, collective bargaining, grievance machinery, and the technological improvements that throw men out of work.

Collective bargaining may change its form and procedure under the pressure of war, but the experience of the last war indicates that the basic problems of industrial relations remain after hostilities cease. Sound labor policies are essential elements of victory. A clear understanding of collective bargaining is even more urgent now than in times of peace. F. S. W.

MIRACLES OF MILITARY MEDICINE. By Albert Q. Maisel. New York: Duell, Sloan & Pearce, Inc. 373 pp. $2.75.

NOWHERE is it disclosed whether or not the author is a doctor, but the entertaining and easily understood chapters in lay-medical language on the subjects of tetanus toxoid, the sulfa quintet, quinine substitutes, as well as processes of healing which are of particular interest to the military surgeon, will be appreciated, particularly by those entering upon the great adventure of war. Those who are tending the home fronts will gain much comfort from this book which carefully explains the manner in which modern medicine and surgery repair and restore the human body. This is one of the few books on this subject which will grip the layman and make the processes usually reserved for the medical profession easily understood by the nonprofessional reader. T. K. V.

THE STORY OF WEAPONS AND TACTICS. By Tom Wintringham. Boston: Houghton Mifflin Company. 230 pp. $2.25.

MR. WINTRINGHAM is no armchair tactician. Versed in ways of modern warfare by reason of service with the Spanish "Loyalists," and a student of tactics through the ages, he has produced an extremely interesting and well-organized volume which should prove valuable to both soldier and civilian.

Breaking down the history of warfare into successive periods averaging roughly 500 years each, he subdivides these into alternating eras when armor, and the shock tactics which armor makes possible, have been in ascendancy—and in eclipse. Specifically, he delimits as the first unarmored period that from prehistory to 479 B.C. Then follows an armored period—479 B.C. to

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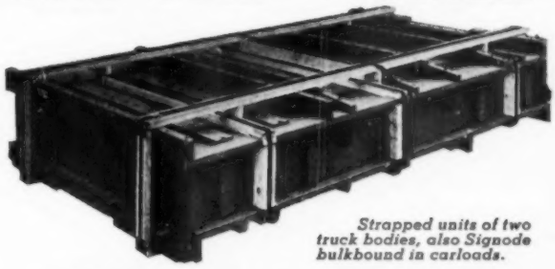

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Book Reviews

378 A.D. The second unarmored period (378 A.D. to 774 A.D.) is succeeded by another armored era extending from 774 to 1346 A.D. The last unarmored period (1346 to 1917) ends with the return of armor in 1917 to inaugurate the current (third) armored period—leading no man knoweth whither.

Having contrived a curve of fluctuations in the use of armor, Mr. Wintringham undertakes to establish its correctness by means of detailed descriptions and discussions of the weapons and tactics employed throughout the six cycles into which it is divided. Whether or not he establishes a complete case, he has certainly managed to employ a novel approach in his scrutiny of man's organized attempts to impose his will upon his fellows, and he expounds his theory with force and clarity.

Though not unduly accented, the author's adhesion to the philosophies entertained by the Spanish "Loyalists" and their Russian collaborators is frequently evidenced through the work. He is an ardent advocate of the guerrilla warfare which has recently served so ably to implement the striking power of the regular Russian forces now sweeping Germany's weakened armies westward. We quote: "The pattern of warfare that can make the *Blitzkrieg* obsolete, the emerging pattern of today, is in my belief that of the Peoples' War. This is a pattern of warfare which treats as principal the active linking of an armed population with an offensive striking force . . . this revolution in warfare will be caused by and will take the shape of a popular anti-Fascist revolution throughout Europe and beyond Europe. To that, the forces working and fighting against Fascism in America or Russia, in the British Empire or China or ruined Europe, will all contribute in their own way." C. G.

Shortage of Victory. By Gabriel Javsicas. New York: D. Appleton-Century Company. 372 pp. $3.

SHORTAGE of victory for both Axis powers and United Nations is analyzed in this very complete and compelling book. The author presents facts, opinions, and deductions, then makes logical conclusions as to the cause and cure of the situation. Mass production, assembly lines, industrial progress, and the invention of weapons in which speed is dominant are all causes of the lack of spontaneity of today's warfare. He emphasizes that premeditation is essential to the waging of modern war and that democratic nations from their very nature may not normally prepare for or wage offensive war. Initial advantages of time and space are with the totalitarian nations. He predicts that if these problems are not solved in this war by the United Nations and if totalitarian nations are not forever kept from acquiring strength and preparing for another struggle, the next war's first battle will be the last. Moreover, the chance that is ours in the present conflict will not be granted in the next. This book will provide more food for thought than the reader can use hurriedly. It is a textbook, well written, on a fascinating and serious subject. T. K. V.

Basic Principles of Weather Forecasting. By Victor P. Starr. New York: Harper & Brothers.

THIS volume is the second in the Harper Geoscience Series. The author is the head of the forecasting unit of the Institute of Meteorology at the University of Chicago. The book contains 125 illustrations.

During the past decade, many universities have come to recognize physical meteorology as a subject of great utilitarian importance. Professor Starr has succeeded, through patience and vigor, in obtaining a group of people who are applying the science of physics to improving the rôle of forecasting. It is more important than ever, in the present world conflict, to train officers and technicians in all branches of the service in the intricacies involved in meteorology.

Book Reviews

New methods of procedure are made available in this book. Both 36-hour and 5-day forecasting are stressed. The author has especially pointed out, through the use of many charts, the importance of the 10,000-foot level.

Professor Starr has not attempted to deal with specialized forecasting, such as fogs, thunderstorms, frost, etc., but has referred the reader to books and literature covering such data. He has, however, attempted to enumerate a number of the salient empirical facts concerning the behavior of cyclones and other weather phenomena of the United States and surrounding regions. He feels that such a study should be supported by statistics, but points out that these do not exist. He hopes to encourage others to help work out the data which will materially improve meteorological theory. F. S. W.

IDENTIFICATION. Harrisburg: The Military Service Publishing Company. $2.

THIS handbook of military uniforms and insignia is surprisingly complete in these days of expansion and change. The descriptions of the uniforms and insignia are brief and clear, and the illustrations are excellent and in complete detail. The glossary of military terms, giving the foreign equivalents of American military terms and grades, will be of value in every headquarters and of general service to our soldiers throughout the world, not only in identifying the grade, but also in pronouncing it.

The book, unfortunately, goes beyond this point. It endeavors to cover the economic, political, educational, and religious backgrounds of the various countries in which our soldiers may find themselves. This detracts from what otherwise is an interesting and valuable contribution to the list of publications relating to World War II. Compilers of information, in their zeal to cover their subject, are almost universally prone to make this mistake. This all-embracing information also includes an attempt to explain the slang of some of our allies. Whether the American soldier is "pitching woo" to a "babe" in America or "smooging" a "sheila" in Australia, his technique will be his own. He will make his point without the aid of a glossary.

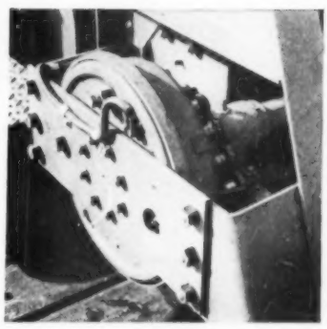
As a pocket handbook confined to the description of uniforms and insignia and a glossary of military terms this publication would have reached a more appreciative public. C. W. R.

A LATIN AMERICAN SPEAKS. By Dr. Luis Quintanilla. New York: The Macmillan Company. 268 pp. $2.50.

THE counselor of the Mexican Embassy in Washington and Minister Plenipotentiary is the author of this book which will enlighten the citizens of the United States regarding the views of our Latin-American neighbors toward us and our common national problems. A keen observer and a shrewd analyst, he writes clearly of the Americas as a whole. The future trends, our joint position in world affairs, and the inhibitions and prohibitions entertained by the Americas for each other here disclosed will raise eyebrows and foster solemn thought regarding past indifferences. This book is a challenge to other Latin-American authors to add to the already too small store of fine treatises like this one. T. K. V.

HAPPY LAND. By MacKinlay Kantor. New York: Coward-McCann, Inc. 92 pp. $1.25.

"HAPPY LAND" is an expression of the deepest feeling of an entire nation only made keener by war. It is the story of Rusty Marsh, his family and friends, in a home town which could be any home town in America. It is the story of picnics and drugstore sodas, of Boy Scouts and sleigh rides, of Sunday School and Indian games. It is the story of real neighborliness among everyday people. It is the story of what we and all the Rusty Marshes are fighting to preserve. J. C. D.



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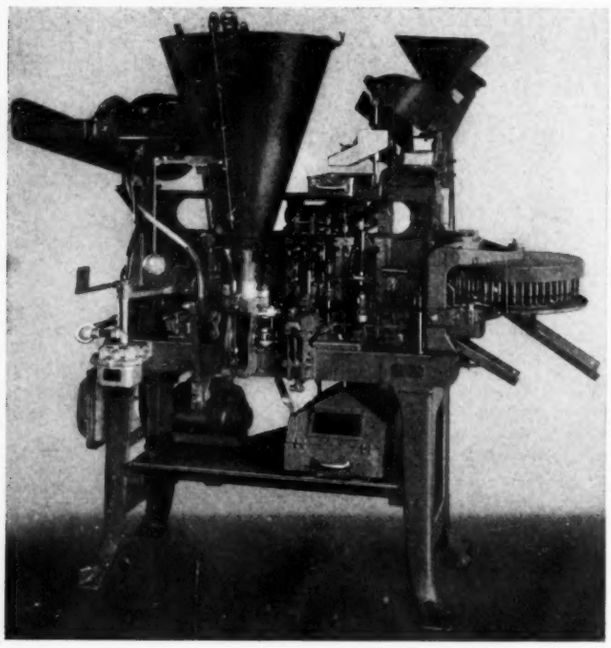

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Book Reviews

ARMY GUIDE FOR WOMEN. By Marion May Dilts. New York: Longmans, Green and Company. 205 pp. $2.50.

EVERY American woman will find the answers to all her many and varied questions pertaining to the new life of her Army man and its effect on her own enclosed in the twenty-three chapters of this volume. That is its well-carried-out purpose through discussions of military law, post etiquette, life at Army camps and stations, Selective Service, organization of the Army, furloughs, decorations, insignia and uniforms, letter-writing, gift sending, and censorship, to mention only a few. This reviewer recommends the book highly as a true Army guide for women. J. C. D.

LISTEN HANS. By Dorothy Thompson. Boston: Houghton Mifflin Company. 292 pp. $2.50.

THE basis of this book is a series of weekly short-wave broadcasts made by Miss Thompson to Germany over the Columbia Broadcasting System. They were addressed to a former friend of Miss Thompson referred to as Hans ("whose name, of course, is not Hans—or is it?") but naturally were intended to reach a wide audience in Germany. They were definitely propaganda. That they were effective is proved by the fact that they irritated Goebbels and were even referred to by Hitler himself.

But the most important part of Miss Thompson's book lies in Part I on "The Invasion of the German Mind" which occupies nearly half the text before the "Conversations with Hans." This amounts to a statement, in detail, of the psychological basis and general philosophy upon which she built her talks. Miss Thompson is a very able journalist. She spent the years from 1920 until she was expelled by the Gestapo in 1934 in Germany. Both from her unusual ability and from her general background of training and experience, and especially from her long residence in Germany with contacts both with its leaders and the men in the street, her words are entitled to serious consideration by those concerned with present and future German-American relationships and, for that matter, by any one interested in present and future international relationships in general.

Her style is clear. There is no difficulty in determining what she means. It is her opinion that the only way to do away with pan-Germanism is to integrate the German nation as a strictly limited nation in a Europe of strictly limited nations. Miss Thompson shares the thought, which is now more or less general, that some sort of world federation is a postwar necessity. She outlines general principles which, in her opinion, would bring together the progressive ideas of all the nations.

In view of the absolute necessity of some sort of *modus vivendi* being worked out for the postwar world, the many sharp differences of opinion as to the form which this must take, and the practical necessity of securing an acceptable reconciliation of these differences, this is a book which should be digested by every one who has an interest in the organization of that world, whether his personal opinion is on the left of that of Miss Thompson, or far to its right. R. H. S.

WINGED MARS. Vol. I: THE GERMAN AIR WEAPON, 1870-1914. By John R. Cuneo. Harrisburg: The Military Service Publishing Company. $2.50.

THIS is the first of three volumes which Mr. Cuneo has planned to publish to fill the gap hitherto existing in the accounts of aviation; namely, its development prior to World War I. Few studies of the air weapon have treated the subject from a functional point of view as a part of the military machine as a whole, and, consequently, an unbalanced and unrealistic conception of the air weapon has resulted.

While dealing mainly with German developments and the struggle to have them become a part of German military strategy

Book Reviews

despite that country's set system of warfare, this first volume does include an outline of the general growth of European air power. A second is intended to bring the account through the campaigns of the first World War, and with these two as a background, a third will be written on the history of the air weapon of the United States. This reviewer has found Volume I a very interesting and readable work generously illustrated with sketches by the author. J. C. D.

TRUCK REPAIR MANUAL. Harold F. Blanchard, Editor. New York: *Motor*—The Automotive Business Magazine. 905 pp.

UNDER supervision of *Motor* magazine's technical staff, the first edition of "Motor's Truck Repair Manual," published in January 1943, was written by factory experts of several truck manufacturing concerns. Prepared in book form with heavy cardboard covers, there is included an alphabetical table of contents and an index of trucks and their major units. Each section contains full particulars on the repair and installation of parts, tools to be used in each operation and the proper method in which to use them, and cautions to be observed in order to avoid errors.

Excellent illustrations, charts, and diagrams are included on almost every page. The quality and clarity of the diagrams are outstanding. Among the subjects discussed are: air cleaners, axles, brake systems, carburetors, clutches, diesel pumps and injectors, diesel engines, gasoline engines, fuel pumps, gasoline gauges, generators, governors, headlamps, ignition systems, magnetos, oil filters, torque dividers, transfer cases, transmissions, shock absorbers, starter switches, steering gears, universals, wheel alignment, and windshield wipers. In fact, so complete is the manual that it probably would not readily lend itself to use in the field by maintenance troops. The size is 8½ by 11 by 2 inches. The book may be used to best advantage in the shop or in the classroom. It is a veritable encyclopædia on the truck.

A reprint of the booklet issued by the Office of Defense Transportation entitled "America's Trucks—Keep 'Em Rolling" is included in the back of the manual. From this reprint, the following statement is quoted: "Every American should realize that serious failures in our transportation system may not cost the lives ordinarily lost in highway accidents but may cost the lives of whole companies of men at the front because they were not supplied with the implements of war necessary to protect themselves. A breakdown of the transportation system of any country at war may easily cost that country the war. Ours must not break down. Do your part to keep America's trucks rolling." B. B. A.

BOOKS RECEIVED

WE LANDED AT DAWN. By A. B. Austin. New York: Harcourt, Brace and Company. 217 pp. $2.

SPHERICAL TRIGONOMETRY. By W. C. Brenke. New York: The Dryden Press. 71 pp. $.80.

AIR NAVIGATION. By Herbert S. Zim. New York: Harcourt, Brace and Company. 304 pp. $3.

SINGAPORE IS SILENT. By George Weller. New York: Harcourt, Brace and Company. 300 pp. $3.

GOING TO OFFICER CANDIDATE SCHOOL. By Martin Goldenring, Nelson A. Voorhees, Tino Suarez. Harrisburg: The Military Service Publishing Company. 142 pp. $1.

HOW TO SHOOT THE U. S. ARMY RIFLE. Washington: The Infantry Journal, Inc. 120 pp. $.25.

SECOND LIEUTENANT'S HANDBOOK. By Lieut. John R. Craf. Stanford University: Stanford University Press. 188 pp. $1.

BASIC MATHEMATICS FOR PILOTS AND FLIGHT CREWS. By C. V. Newsom, and H. D. Larsen. New York: Prentice-Hall, Inc. 144 pp. $2.

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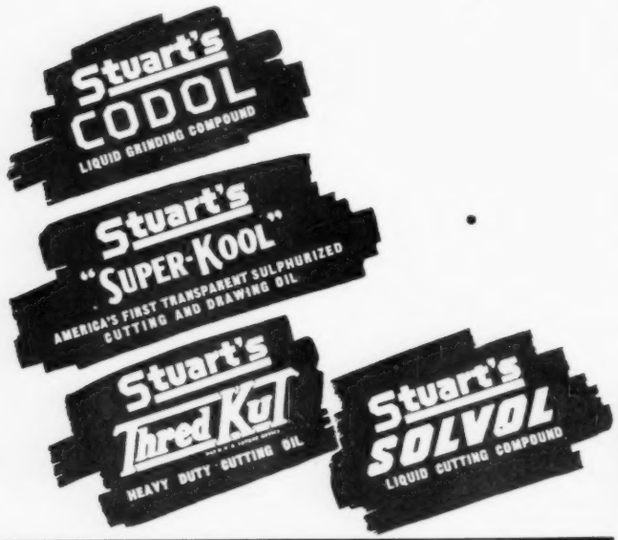

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